

PM014 – 29 January 2024

Update on PINNs

Application to Urban Wind Field Dispersion Studies

Script Version v5

- 1) PINN is now completely customizable – customizable input and output parameters, batch normalization, dropout rate, neuron number, number of hidden layers – all options in the config file (PM007)
- 2) Saving of all the losses (not just the total loss) (PM007)
- 3) Plotting of loss vs epochs now automatic (PM007)
- 4) Boundary conditions – relaxed no slip condition included (PM007)
- 5) New angles included (PM007)
- 6) Smaller batch sizes (I disagree) – customizable from config file (PM007)
- 7) Testing and Predicting Loss during training phase (PM008)
- 8) Inlet Boundary Conditions added (PM008)
- 9) Inlet Boundary for the Z-direction made to follow a log equation (PM009)
- 10) Debugged for no slip loss BC (PM009)
- 11) Activation function updated to an exponential linear unit instead of ReLu {arXiV: 1511.07289} (PM0010)
- 12) Script is being modified for TPU use (PyTorch → Tensorflow) (PM010)
- 13) Entire script revamped for optimisation (PM011)
- 14) Adaptive Weighting Scheme implemented (PM011)
- 15) Moving averages for stopping condition implemented (PM011)
- 16) Amount of data to be considered for data loss is configurable (PM011)
- 17) Plotting divergence implemented (PM011)
- 18) When running in batch mode, each batch now contains a fair representation of all angles in the training phase (PM011)
- 19) Script has been modified for TPU use for data loss only (PyTorch → Tensorflow) (PM011)
- 20) Divergence computations now compares numerical differentiation on the unstructured grid vs PyTorch's autograd (PM012)
- 21) **Normalization transformation fixed for Divergence computation (PM014)**
- 22) **RANS computation added (PM014)**
- 23) **Script to obtain derivatives from Paraview (PM014)**

Scripts v5 – Preliminary Results

Some Parameters

Infinite epochs - Simple Moving Average stopping condition

128 Neurons for the PINN unless otherwise specified

We have the data for 13 angles, [0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180] in degrees

We concatenate the data for angles = [0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180] and then take 99% of the dataset with random seed = 42 for training and 1% for testing

By using 99% of the whole dataset we hope to make the NN learn about wind angle such that the parameters become functions of the wind angle

Then using the trained neural network we predict the data for angle = 135

For this run, we will only have input parameters to be [X, Y, Z, cos(\theta), sin(\theta)] and the output parameters will be [Pressure, U, V, W, TurbVisc]

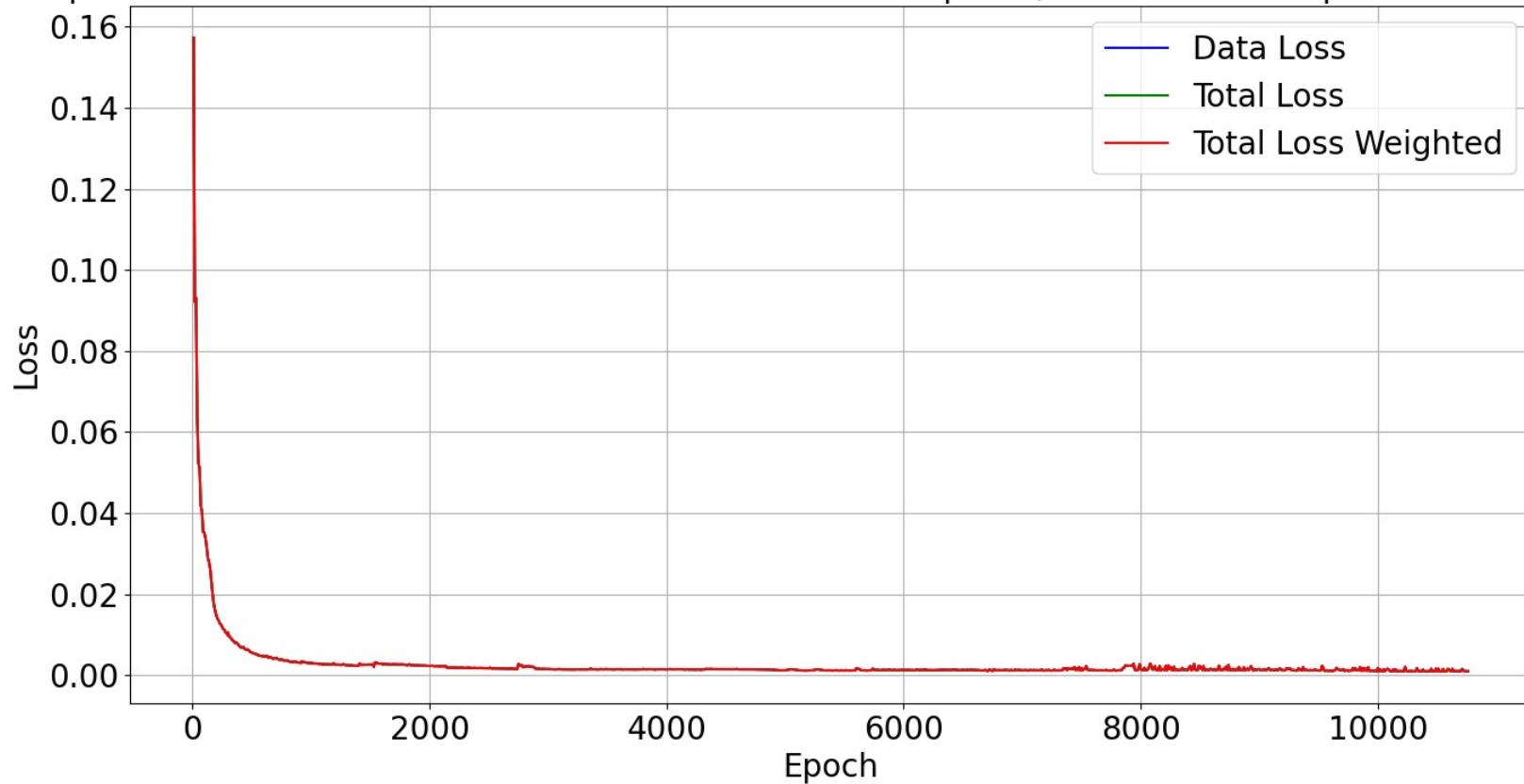
Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

Scripts v5 – TESTING

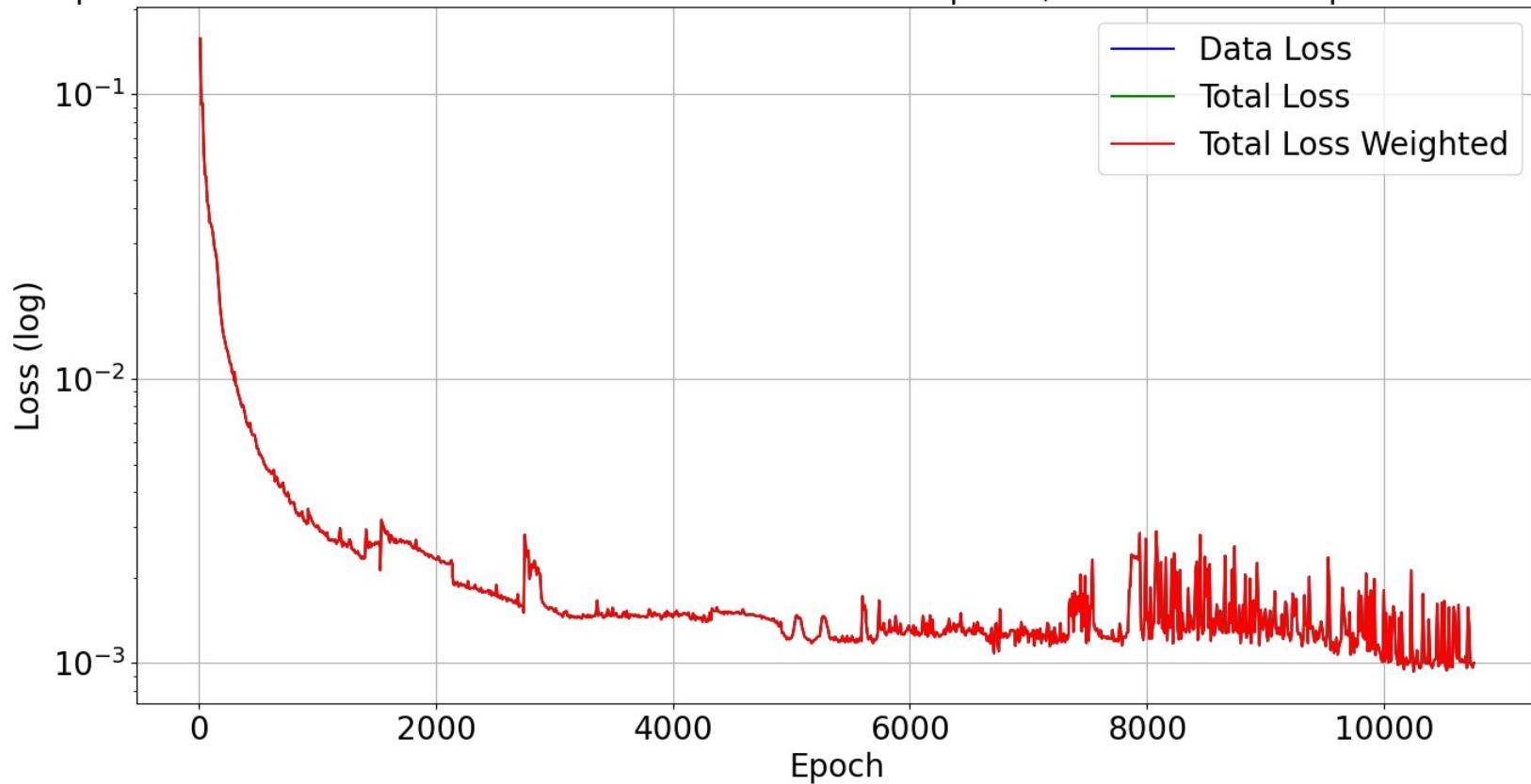
Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop
Logging Plots (Training)

Epoch vs Loss - Time Taken = 1752.50 hours for 10760 Epochs; Time Taken Per Epoch = 0.16 hours

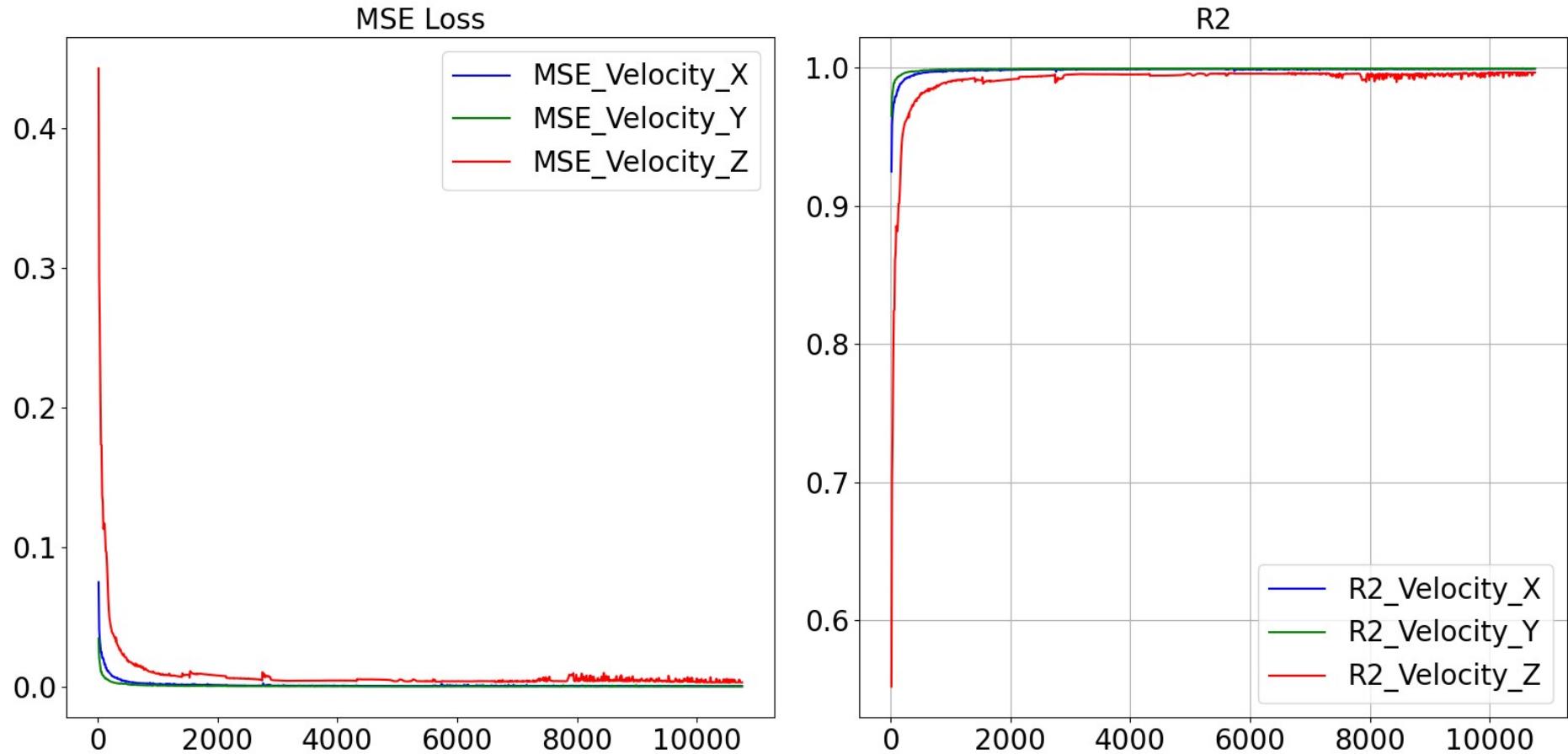


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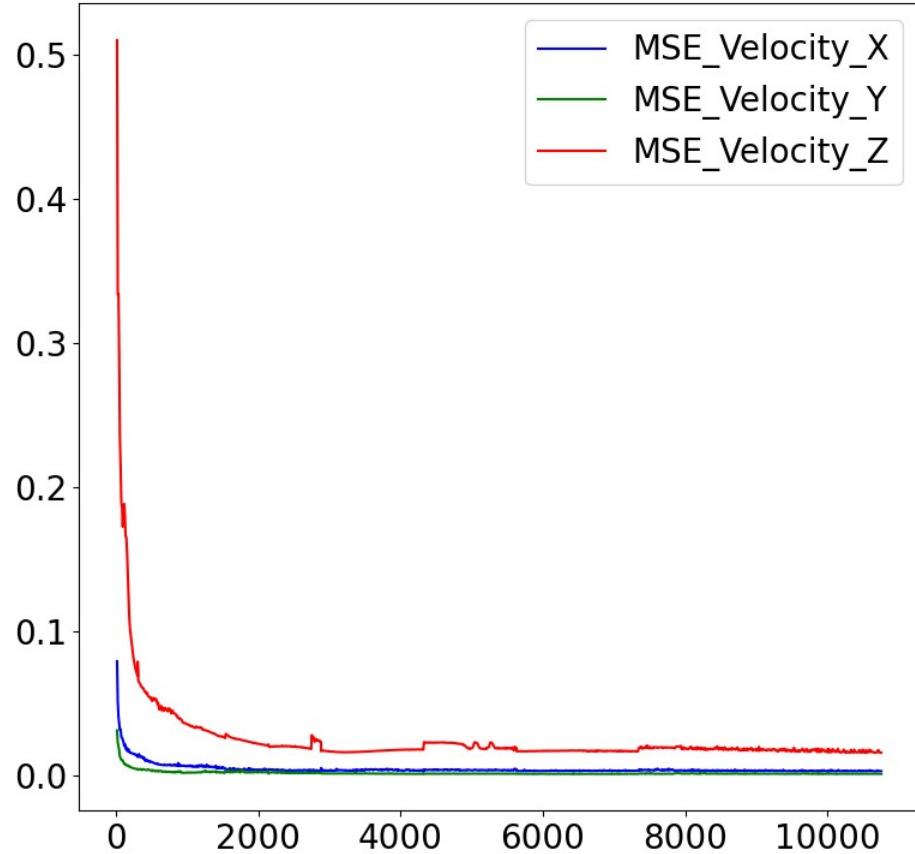


Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop
Logging Plots (Testing)

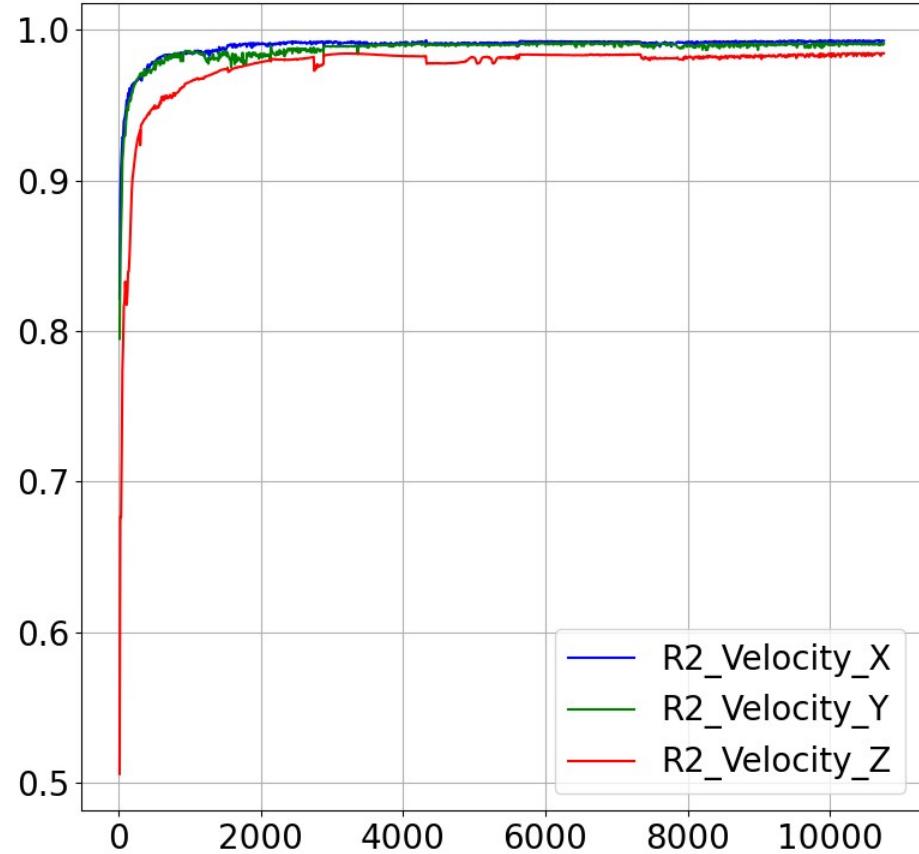


Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop
Logging Plots (Predicting 135)

MSE Loss



R2



Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

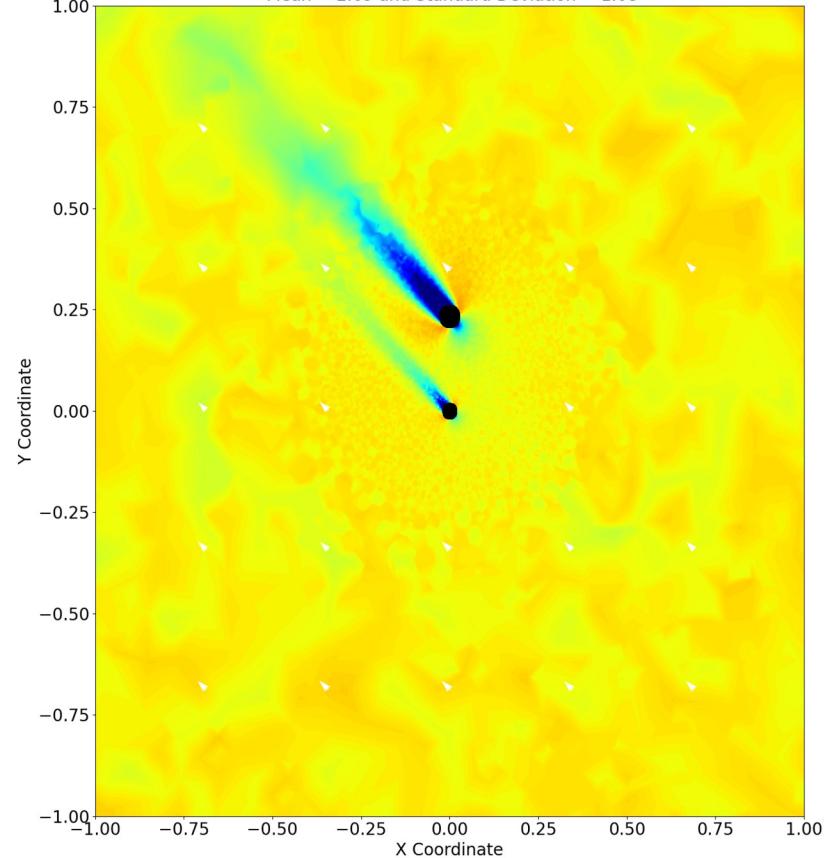
Scripts v5 – PREDICTING

Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop
Predicting Results – Metrics (Angle = 135)

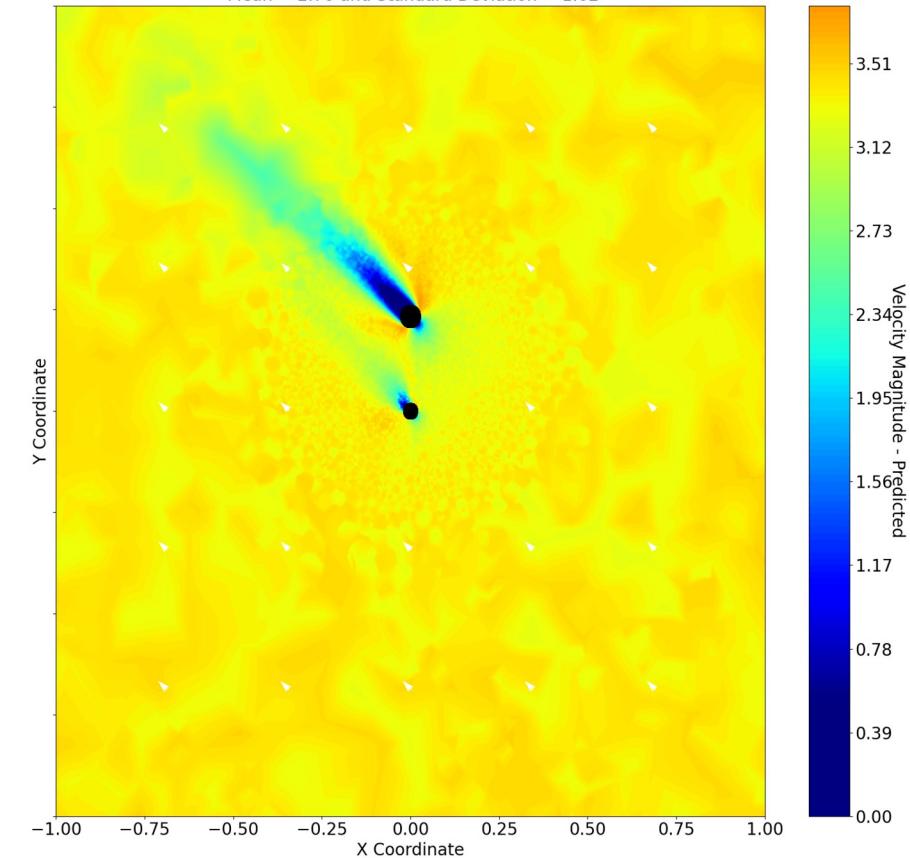
Variable	MSE	RMSE	MAE	R2
Pressure	0.10894191	0.3300635	0.24849545	0.93555115
Velocity:0	0.00762226	0.08730558	0.06221749	0.99252153
Velocity:1	0.00936545	0.09677526	0.06766404	0.99089883
Velocity:2	0.0005134	0.02265838	0.01144017	0.98430637
TurbVisc	0.07082512	0.2661299	0.20224182	0.9994839

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Mean = 2.69 and Standard Deviation = 1.08

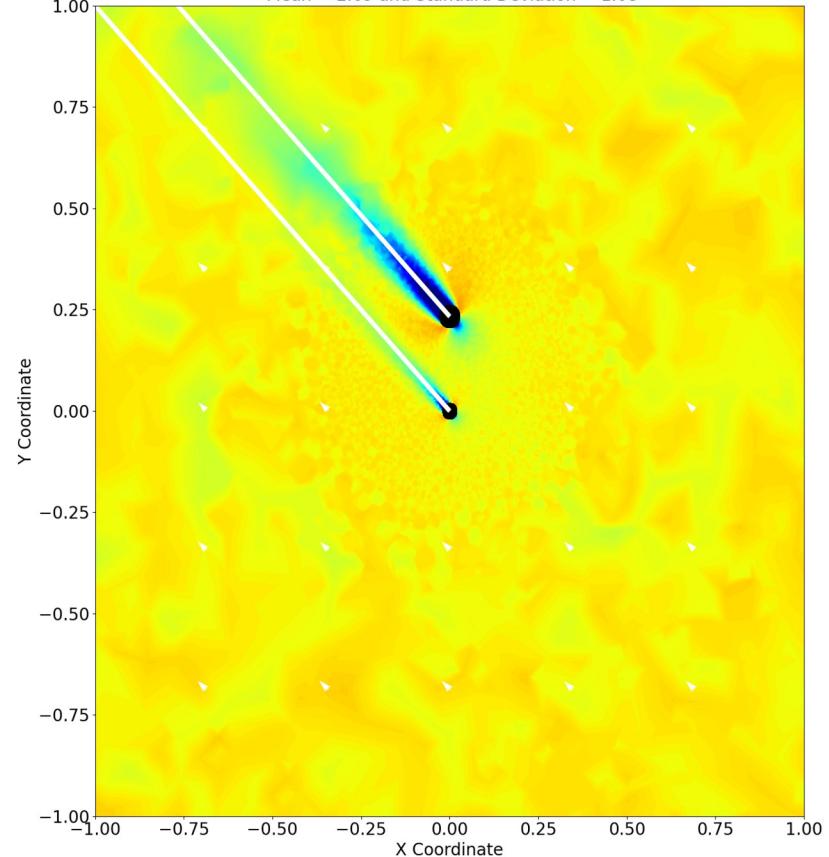


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Mean = 2.70 and Standard Deviation = 1.02

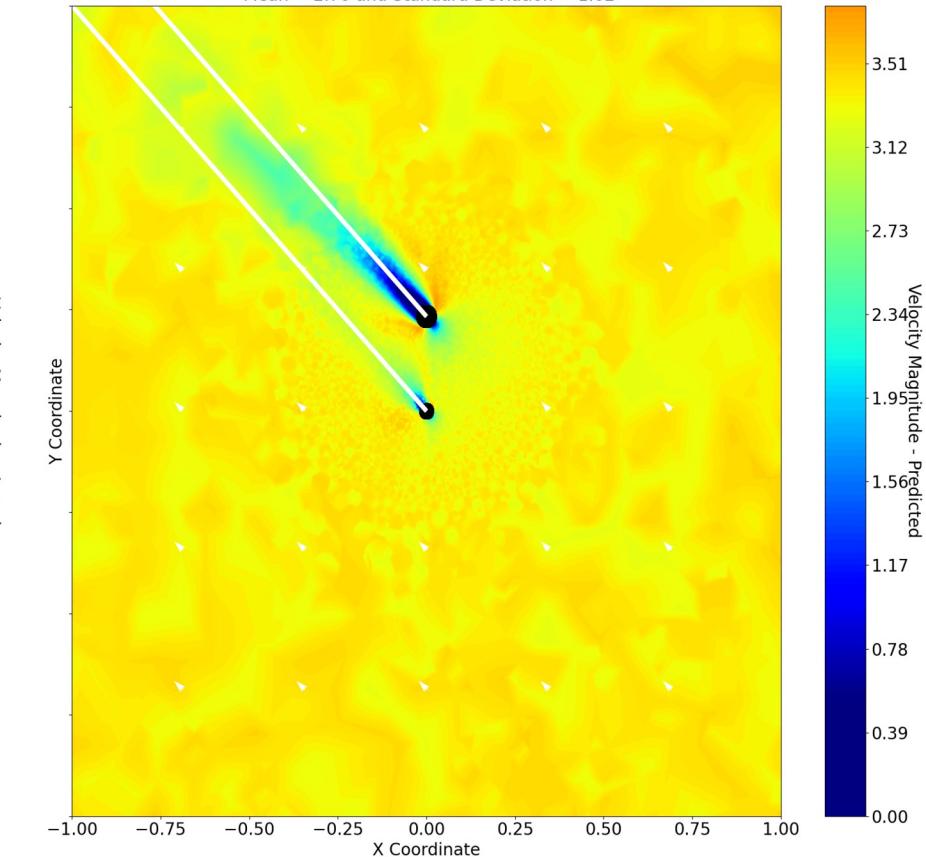


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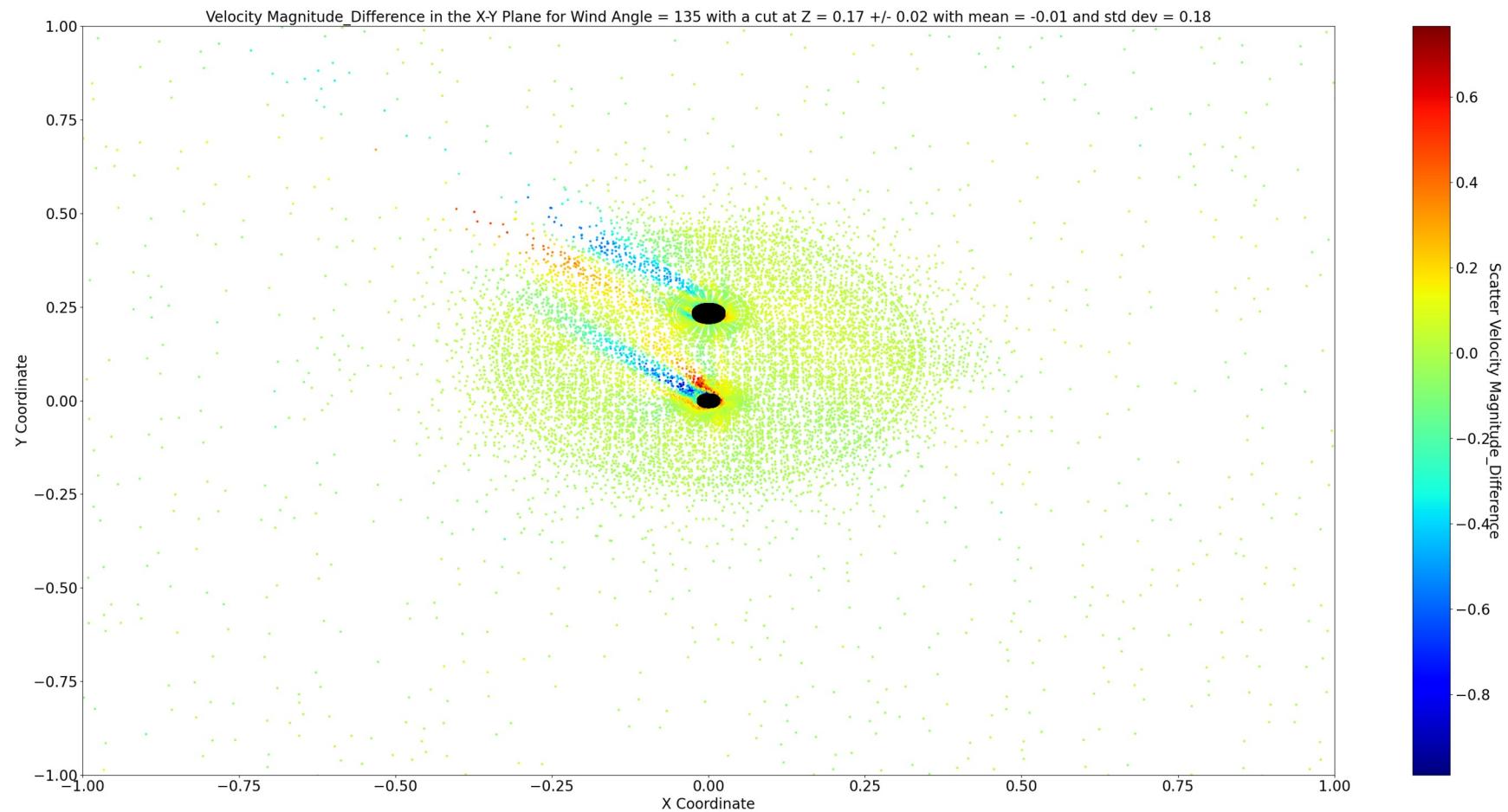
Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
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Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

Scripts v5 – DIFFERENCE

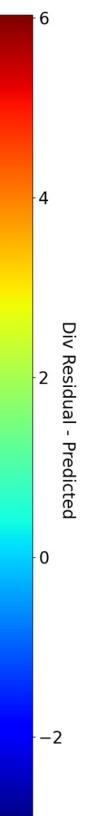
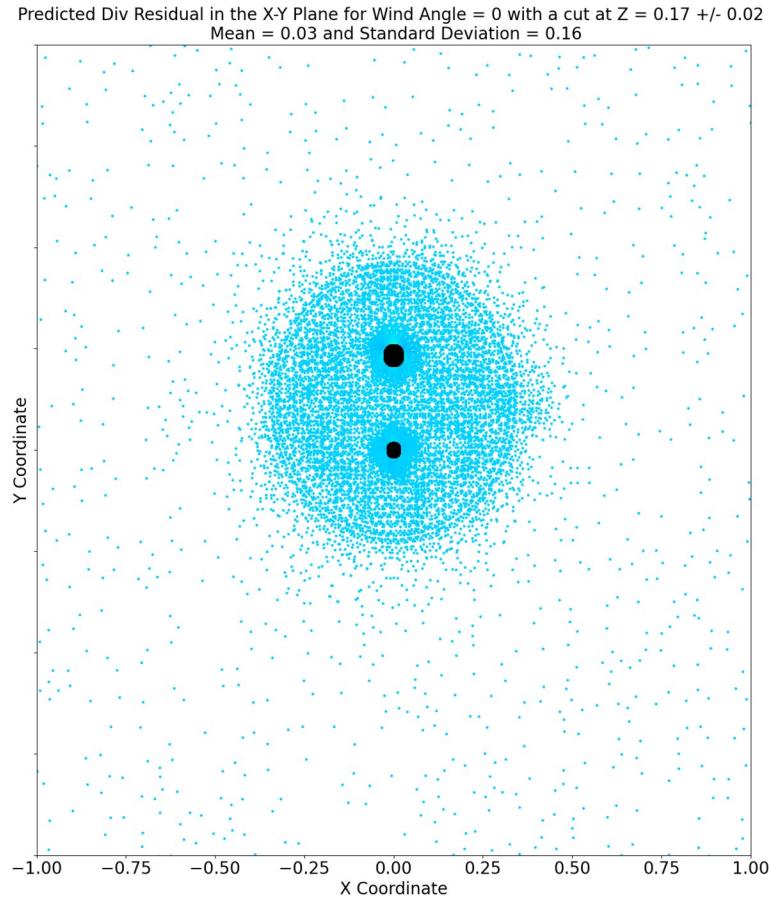
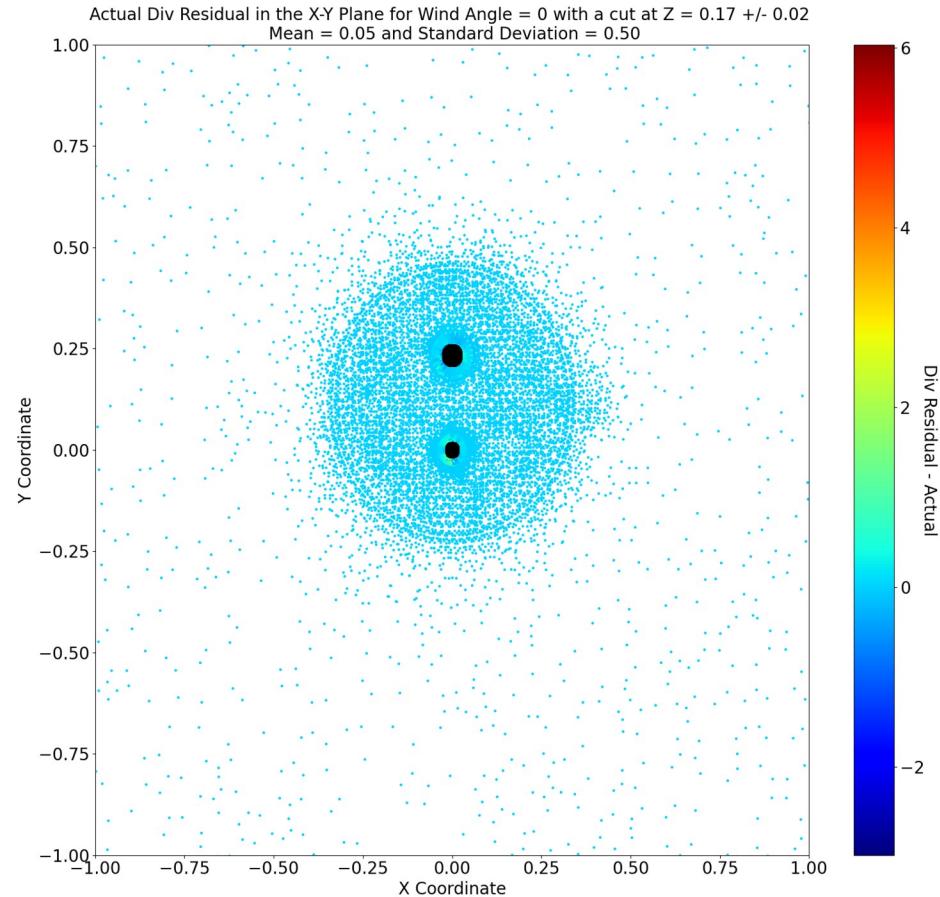


Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

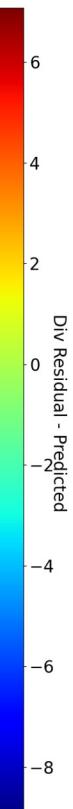
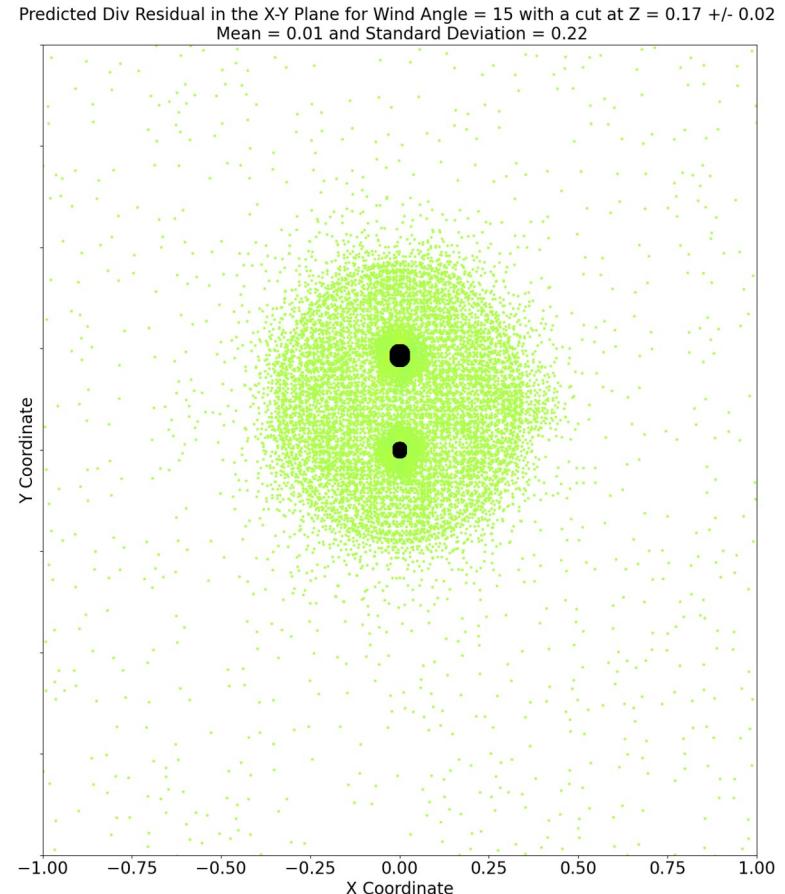
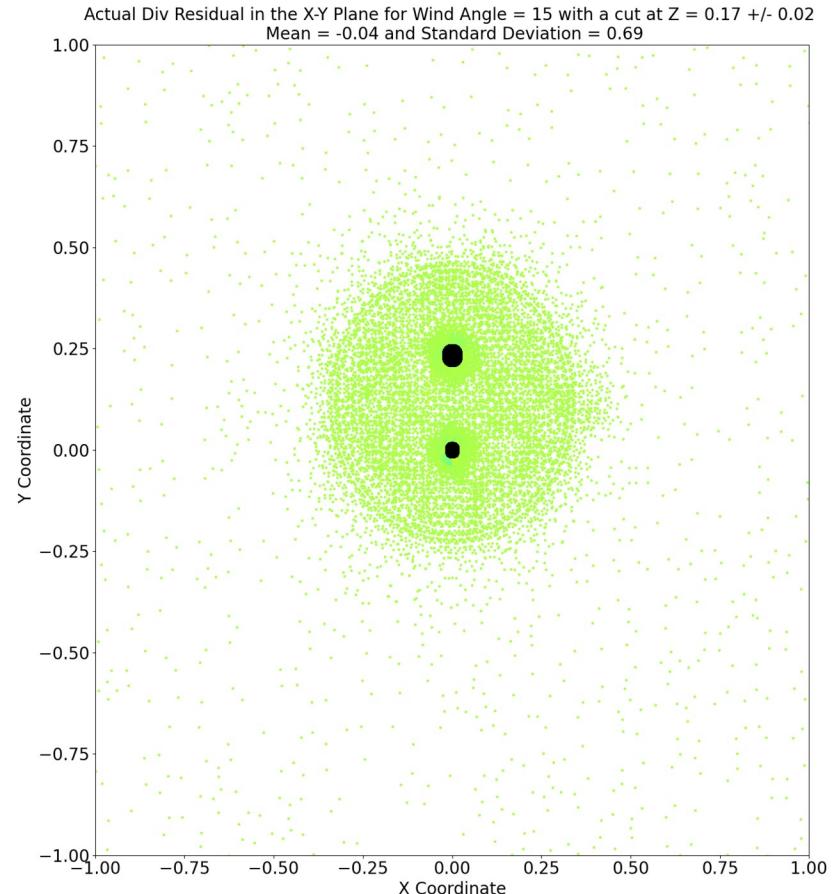
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

Scripts v5 – DIVERGENCE

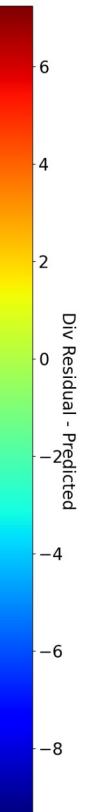
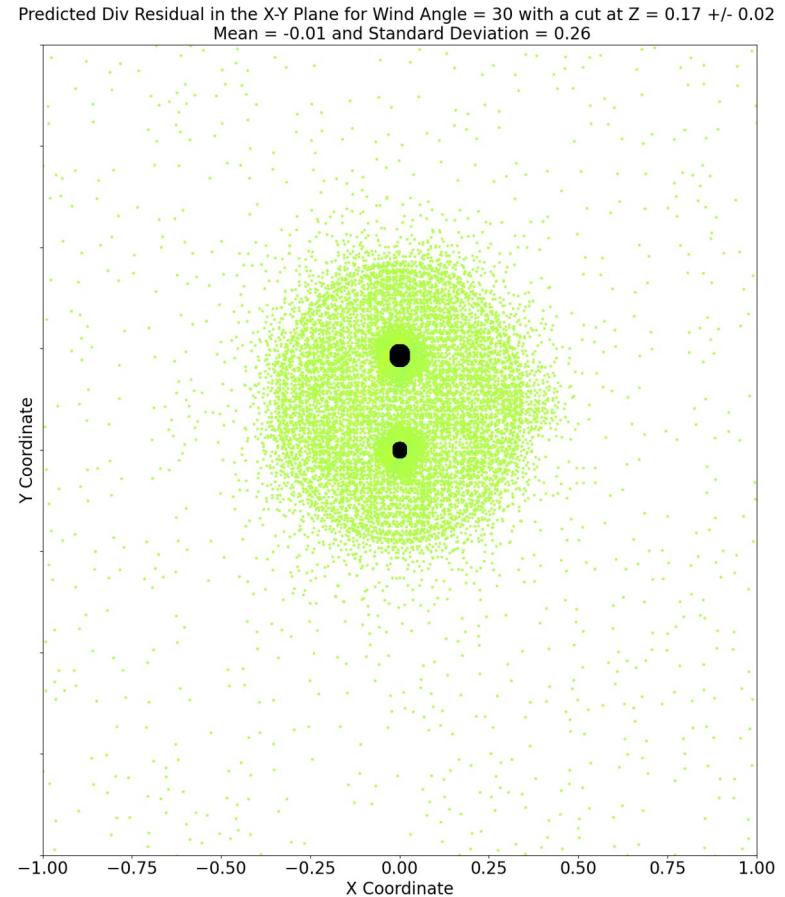
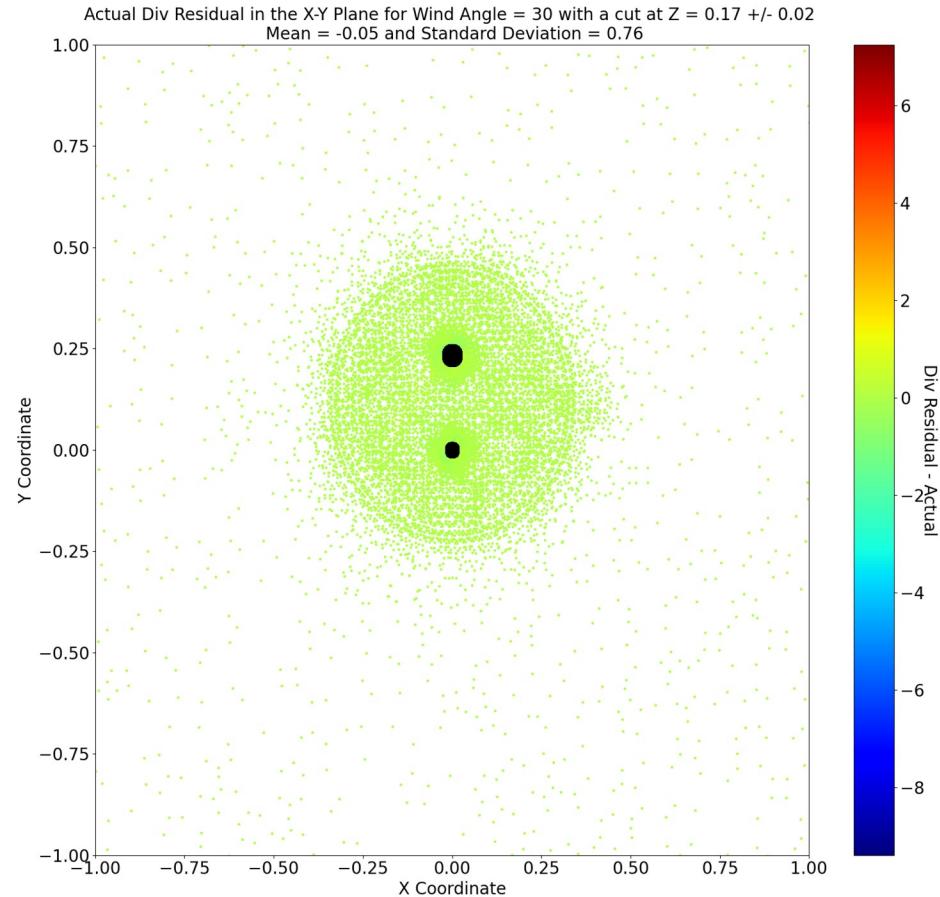
Comparison of Actual vs. Predicted values with Wind Angle = 0 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



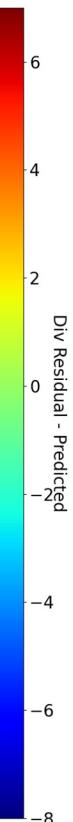
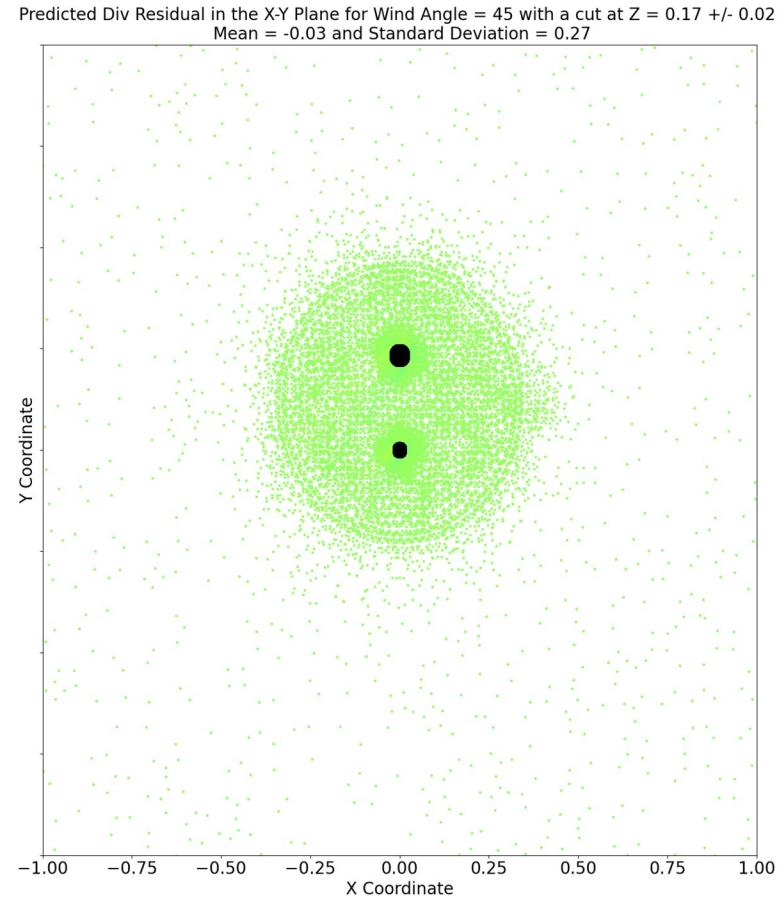
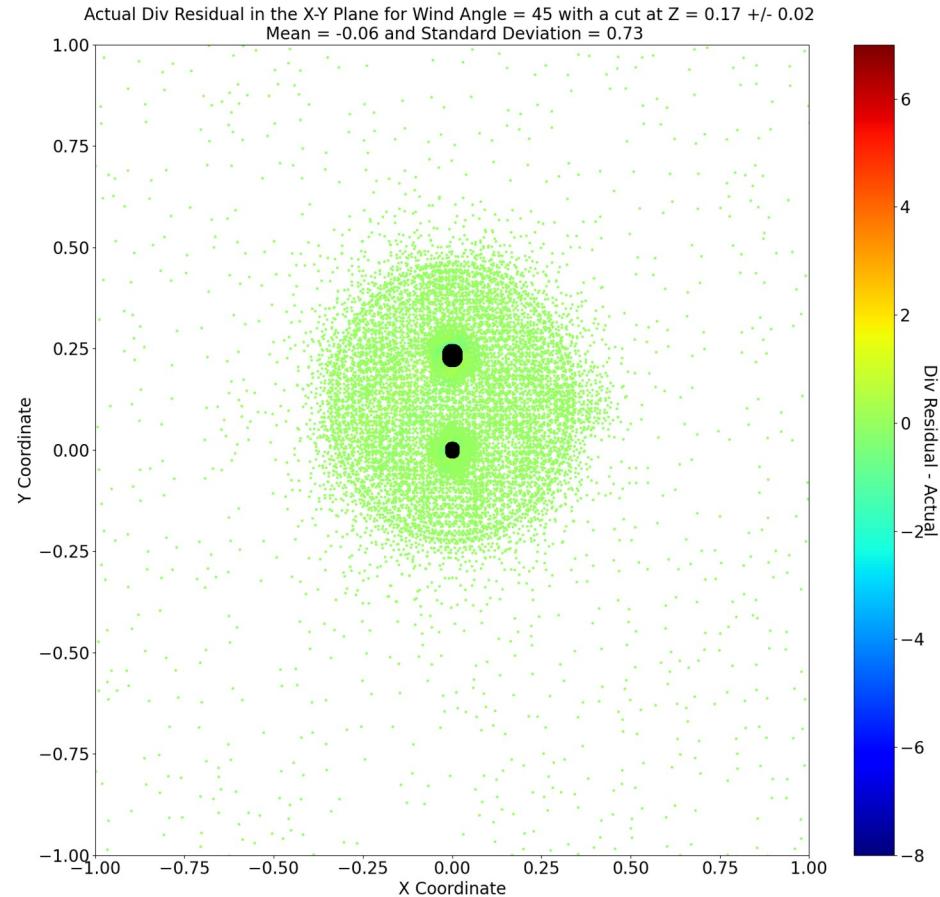
Comparison of Actual vs. Predicted values with Wind Angle = 15 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



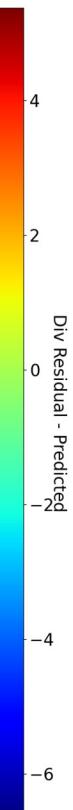
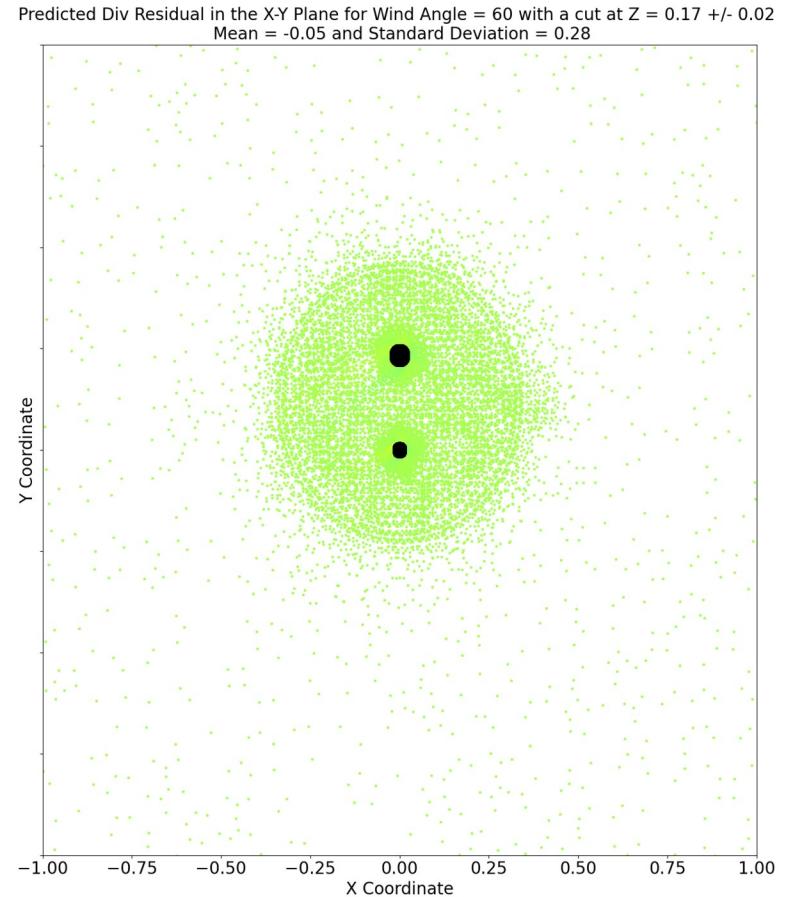
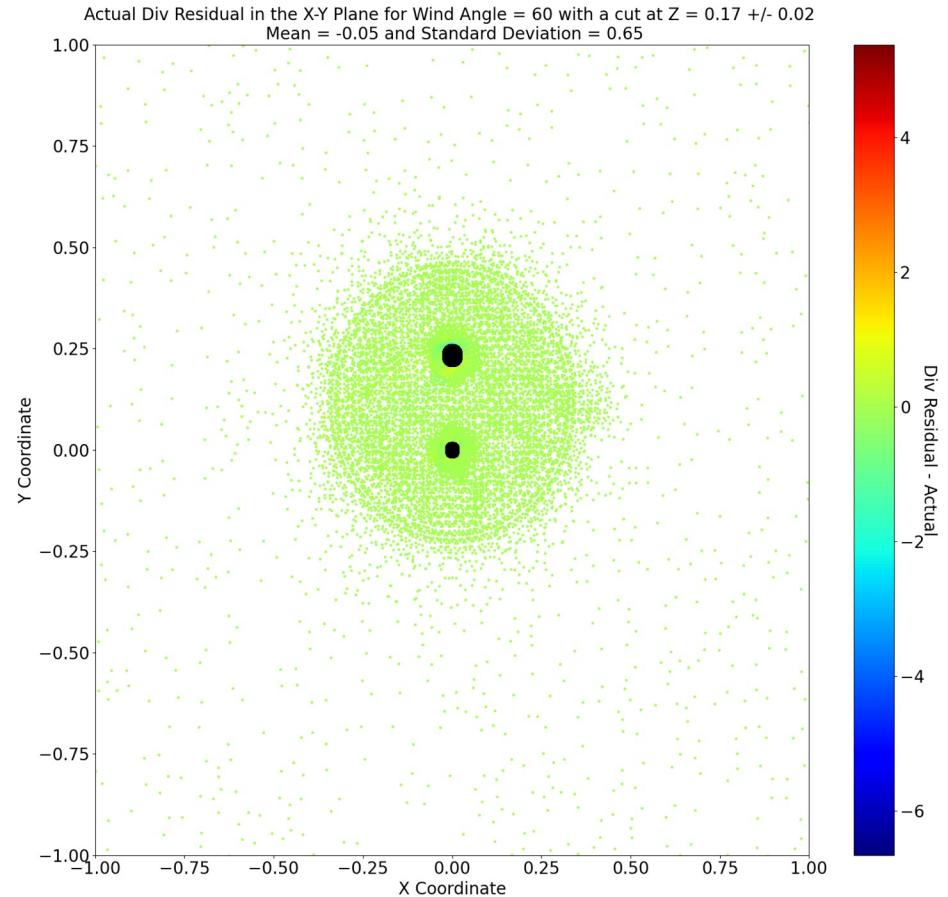
Comparison of Actual vs. Predicted values with Wind Angle = 30 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



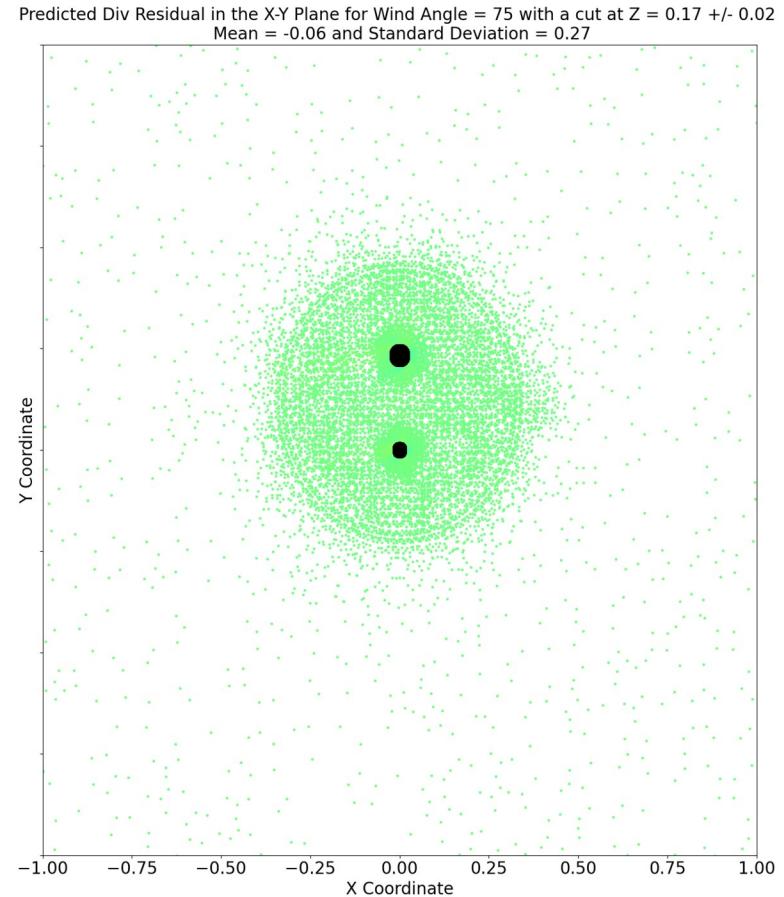
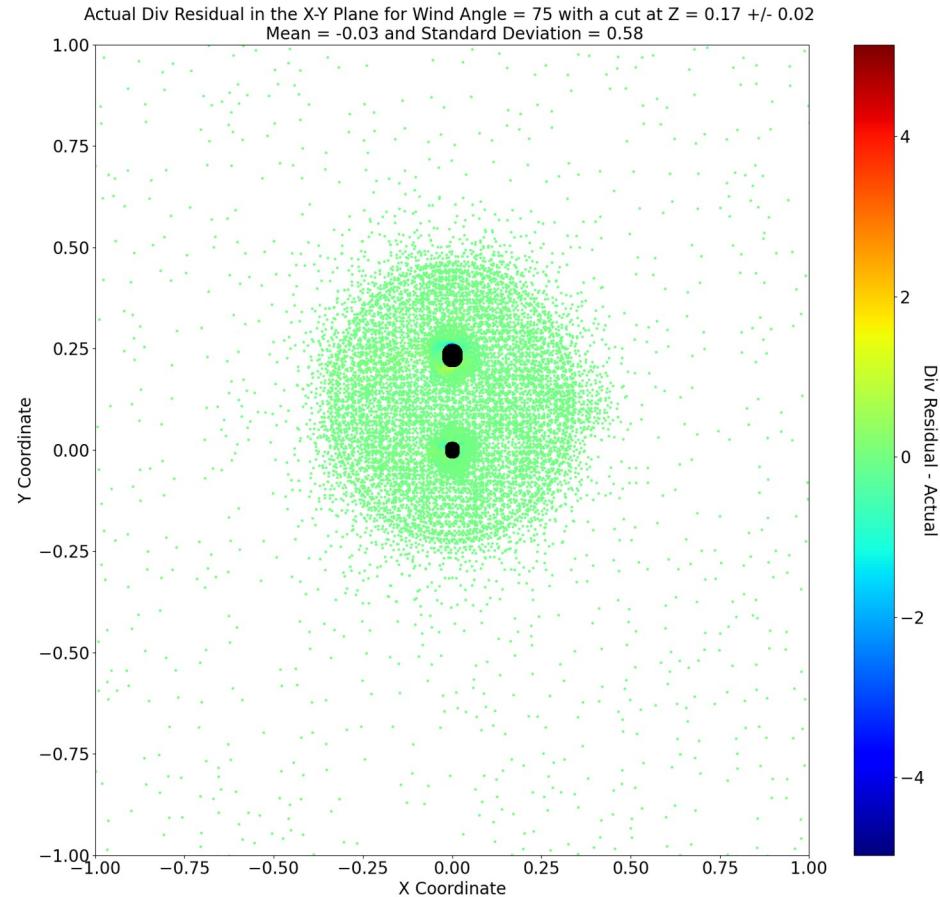
Comparison of Actual vs. Predicted values with Wind Angle = 45 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Comparison of Actual vs. Predicted values with Wind Angle = 60 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



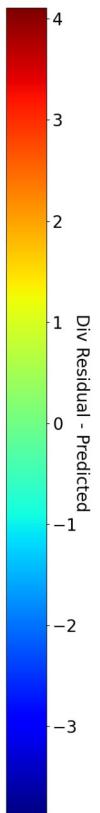
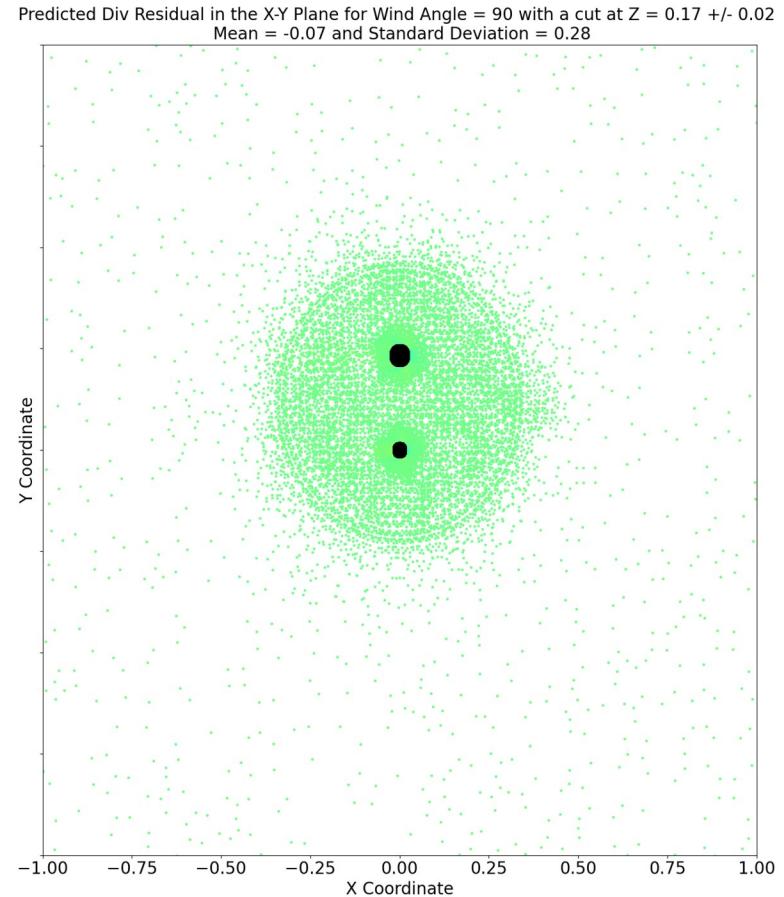
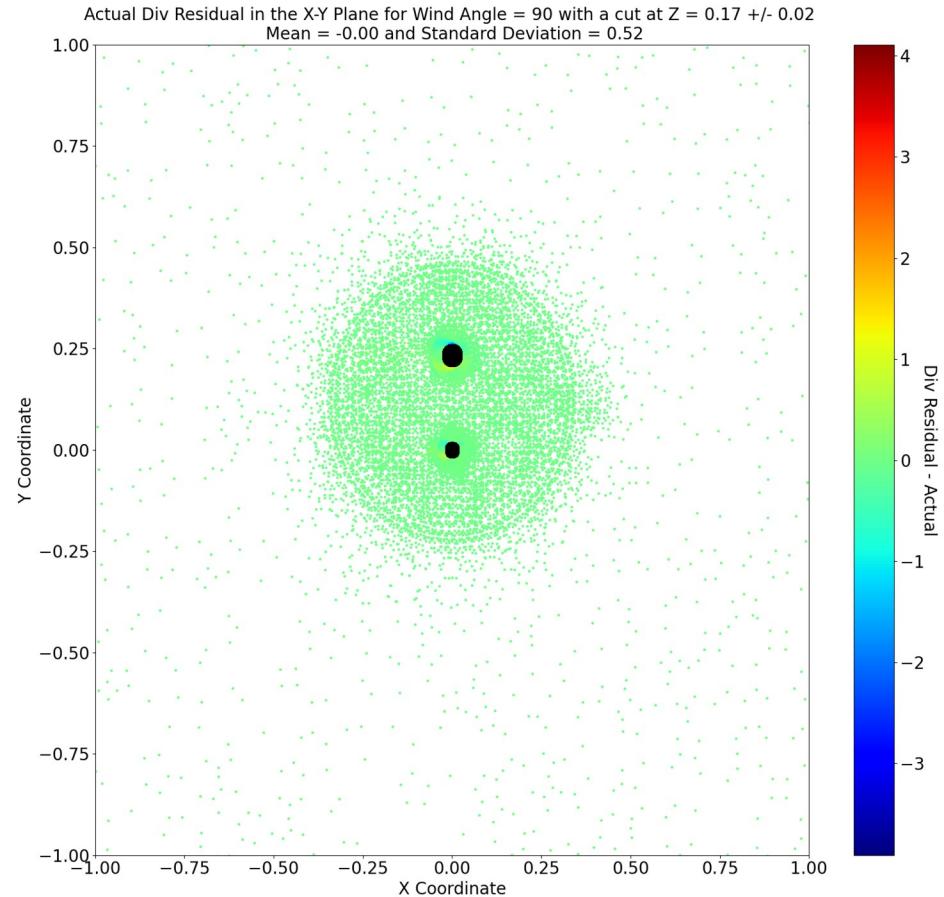
Comparison of Actual vs. Predicted values with Wind Angle = 75 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



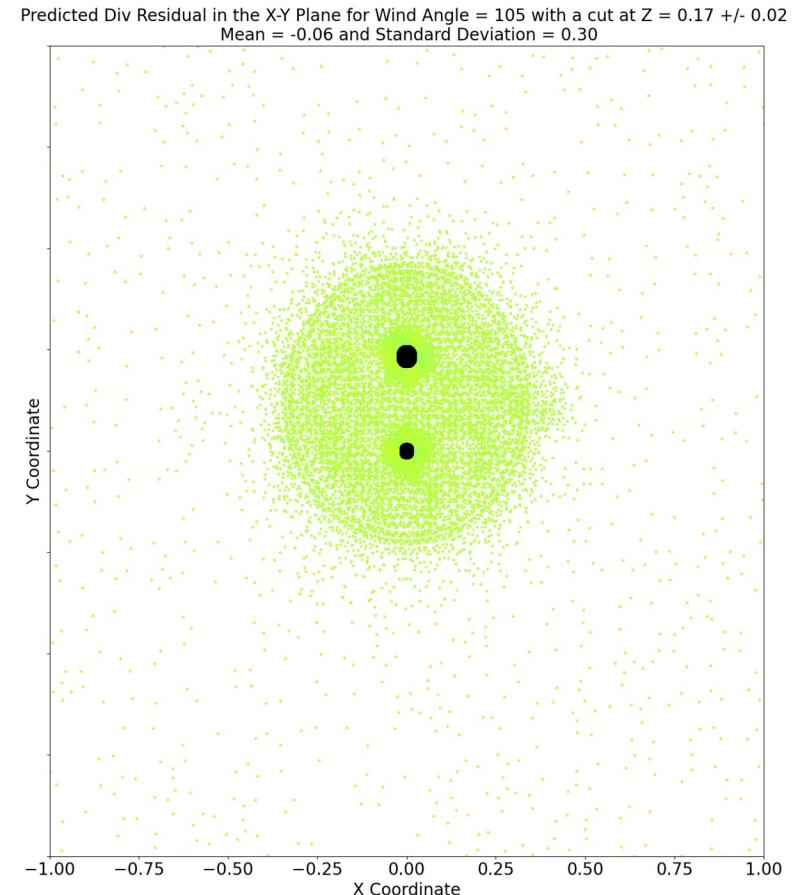
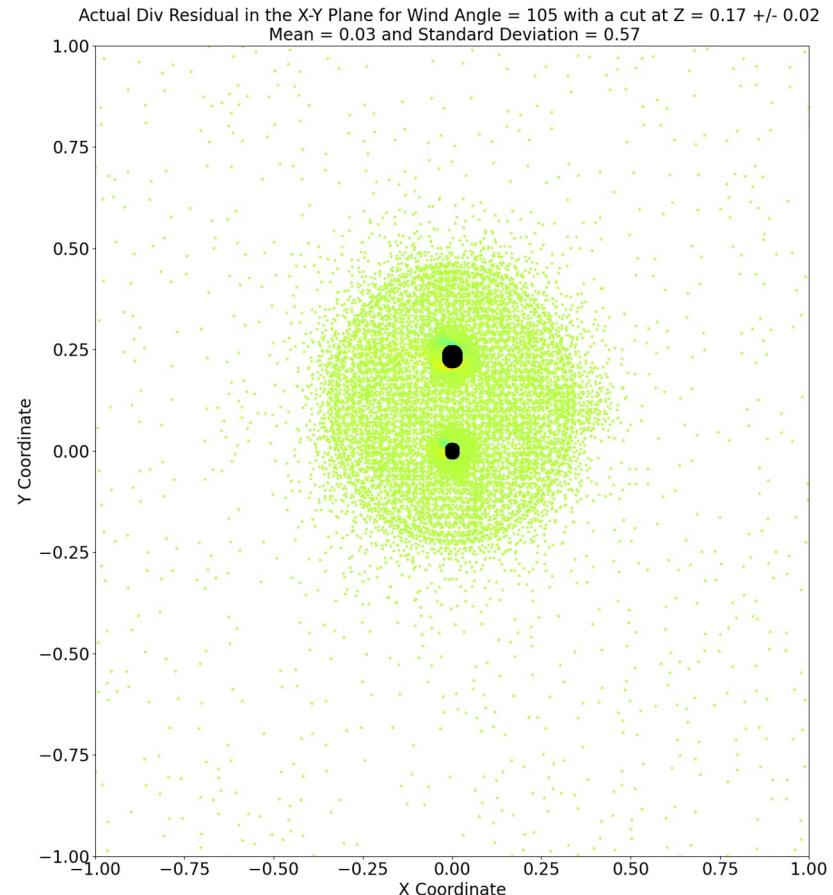
Div Residual - Predicted

-4
-2
0
2
4

Comparison of Actual vs. Predicted values with Wind Angle = 90 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Comparison of Actual vs. Predicted values with Wind Angle = 105 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Div Residual - Actual

-2

0

2

-2

-4

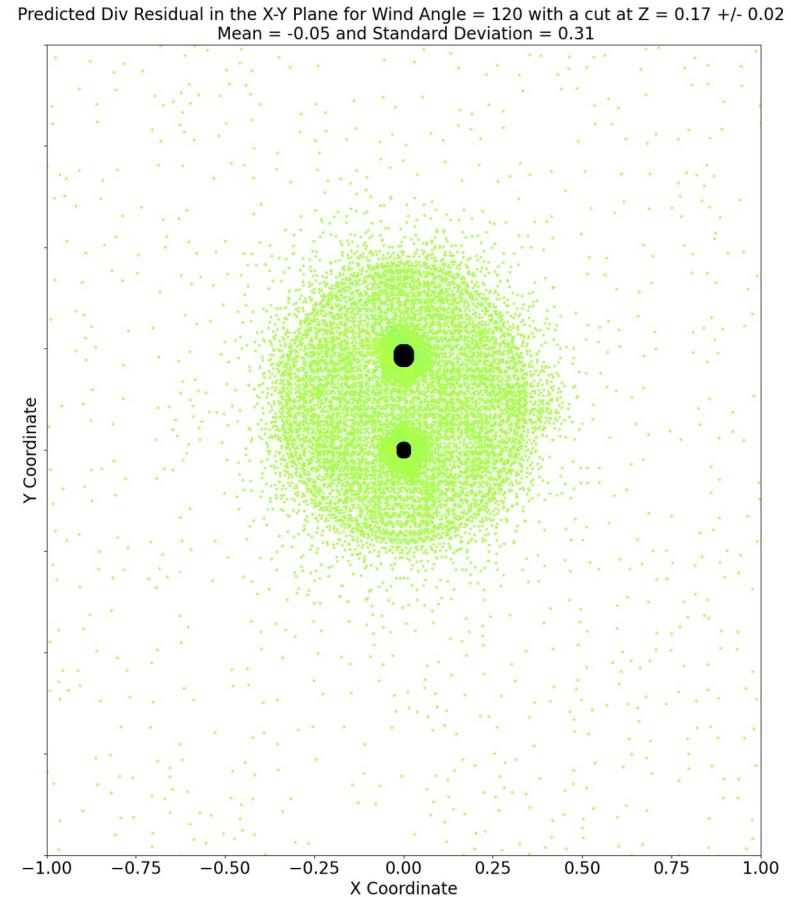
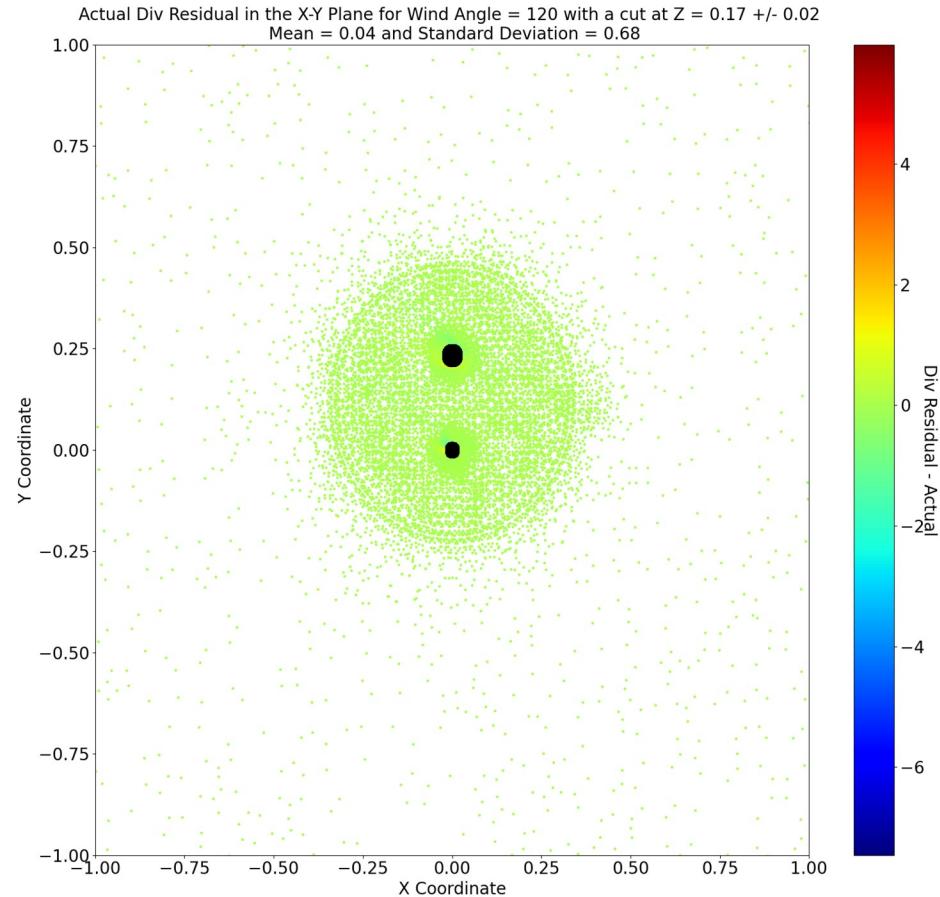
2

0

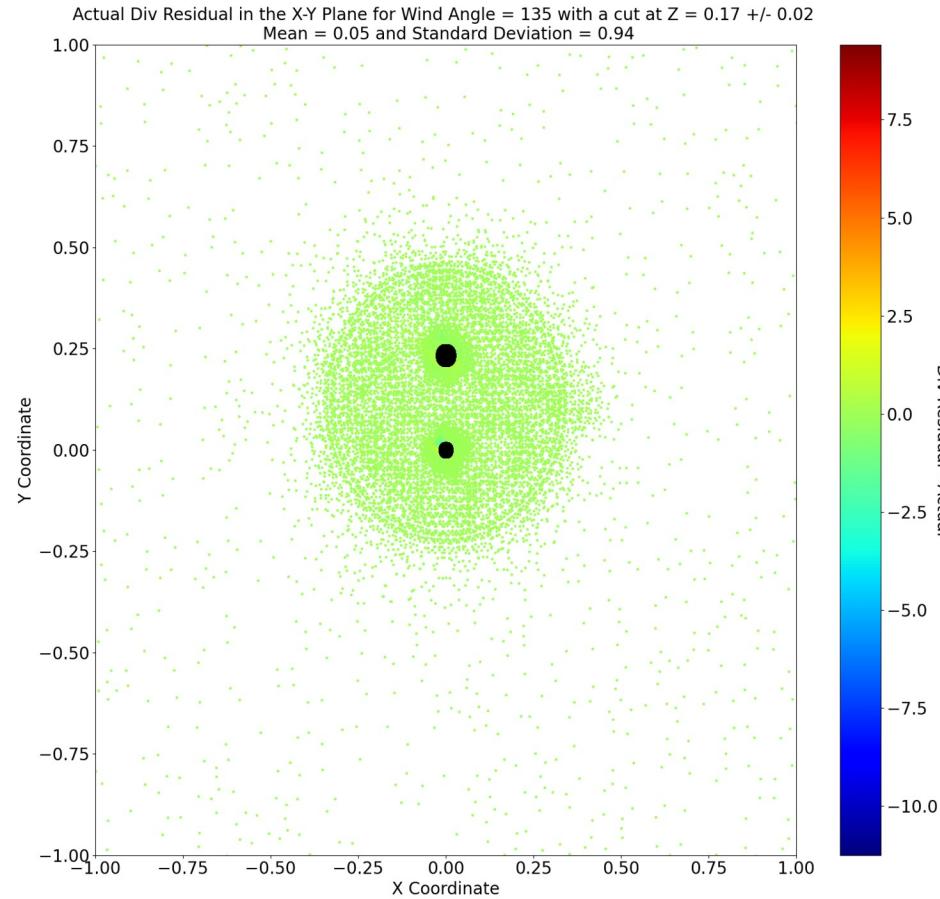
-2

-4

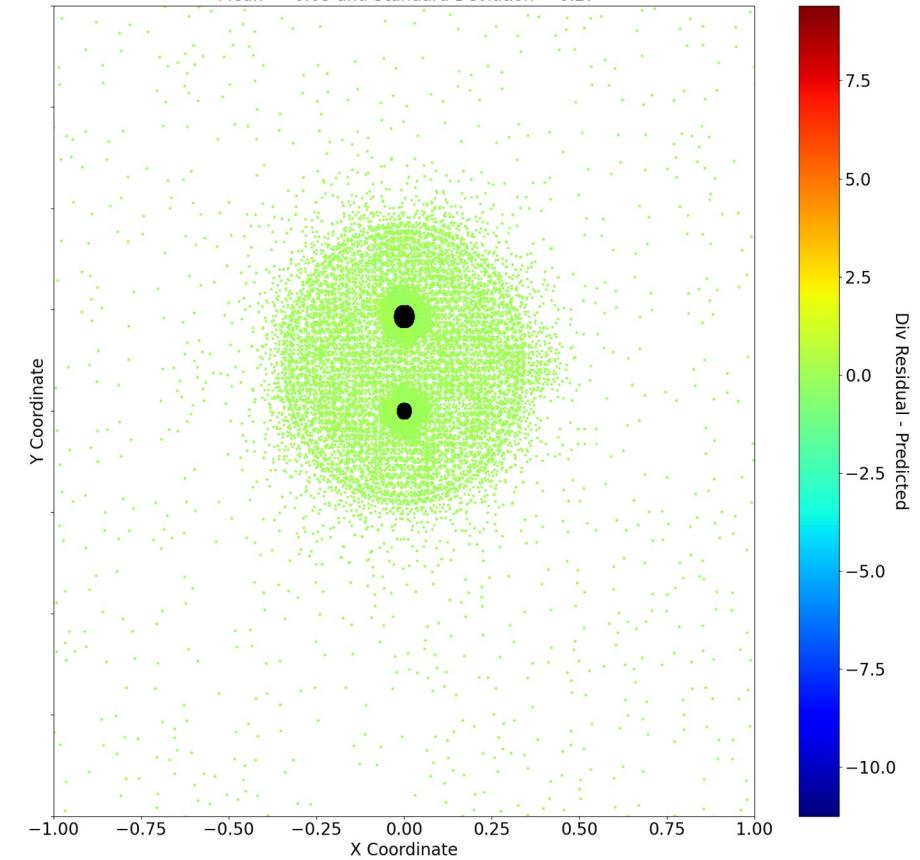
Comparison of Actual vs. Predicted values with Wind Angle = 120 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



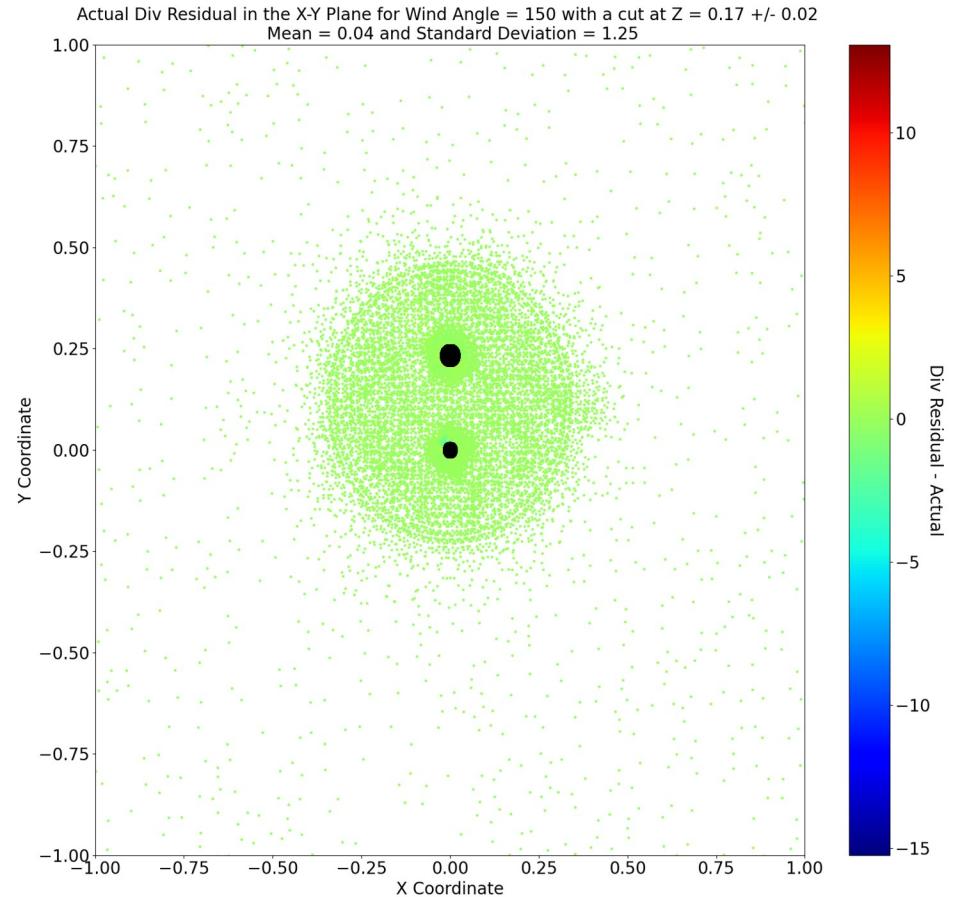
Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



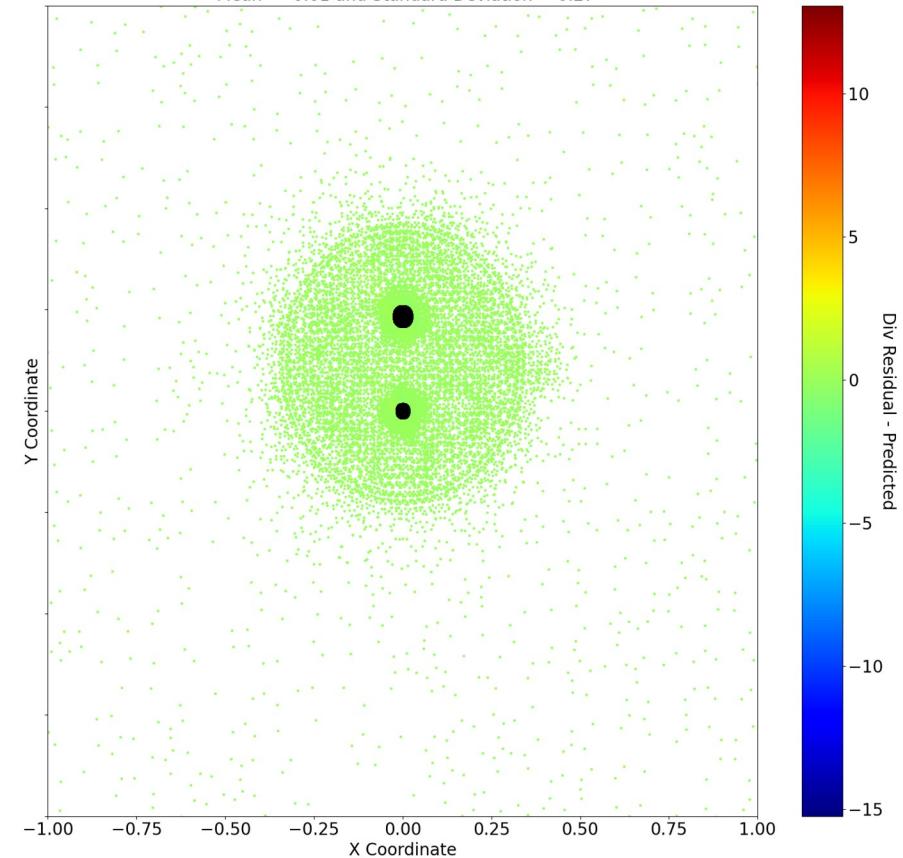
Predicted Div Residual in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Mean = -0.03 and Standard Deviation = 0.27



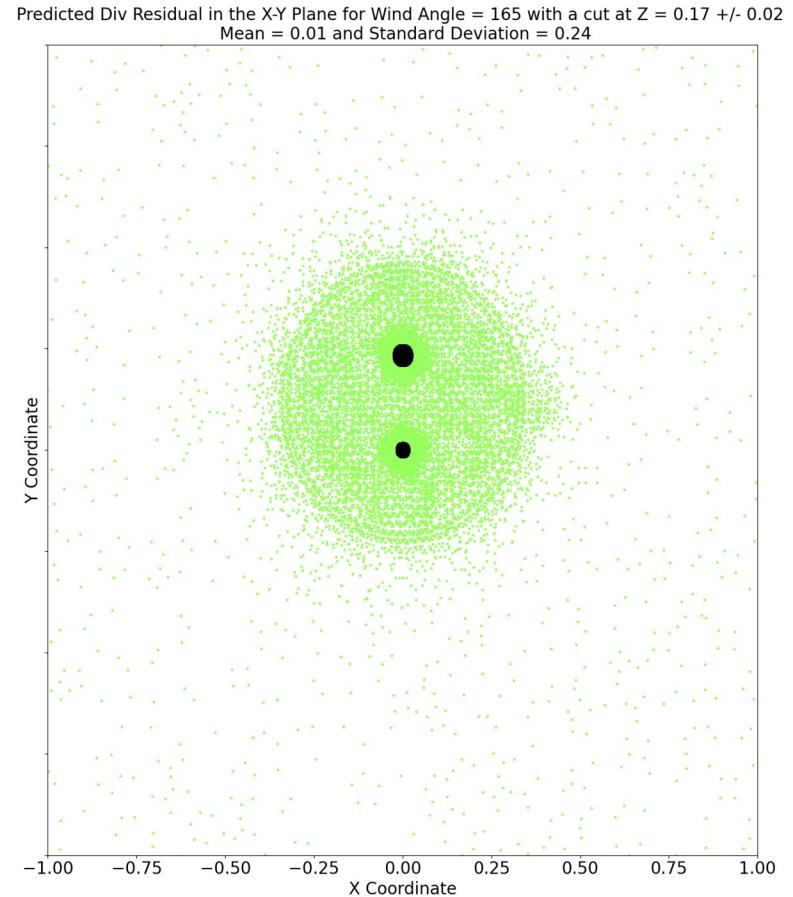
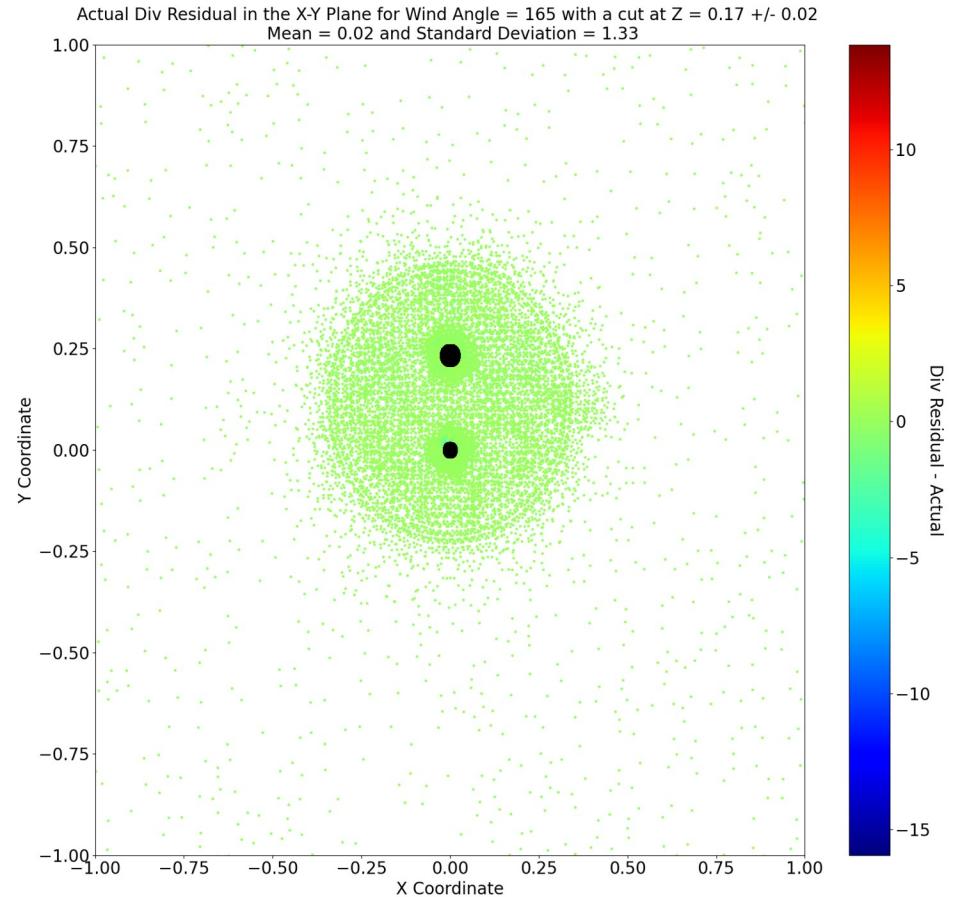
Comparison of Actual vs. Predicted values with Wind Angle = 150 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



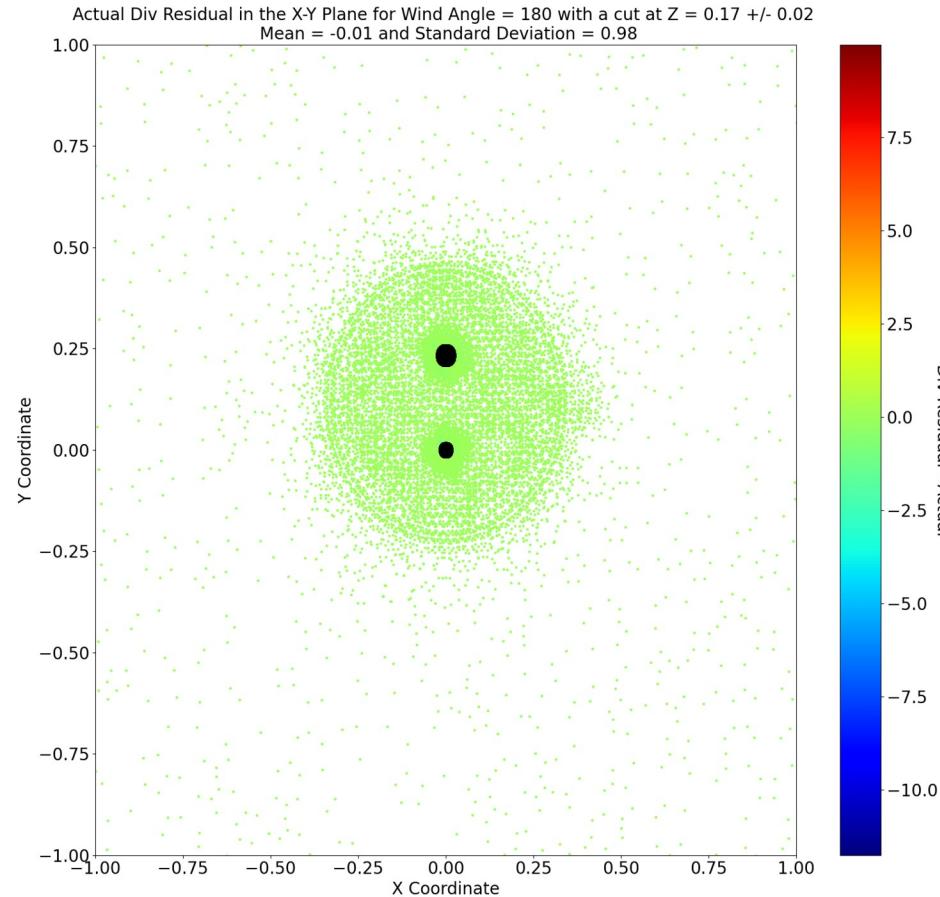
Predicted Div Residual in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02
Mean = -0.01 and Standard Deviation = 0.27



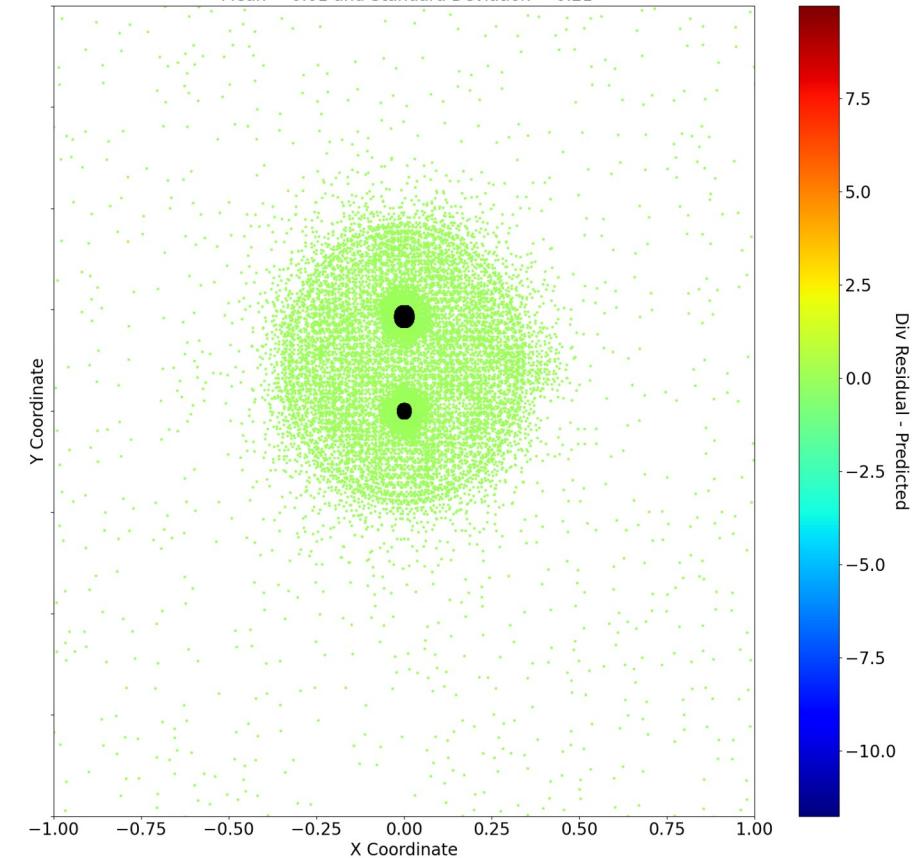
Comparison of Actual vs. Predicted values with Wind Angle = 165 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Comparison of Actual vs. Predicted values with Wind Angle = 180 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Predicted Div Residual in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02
Mean = 0.01 and Standard Deviation = 0.21



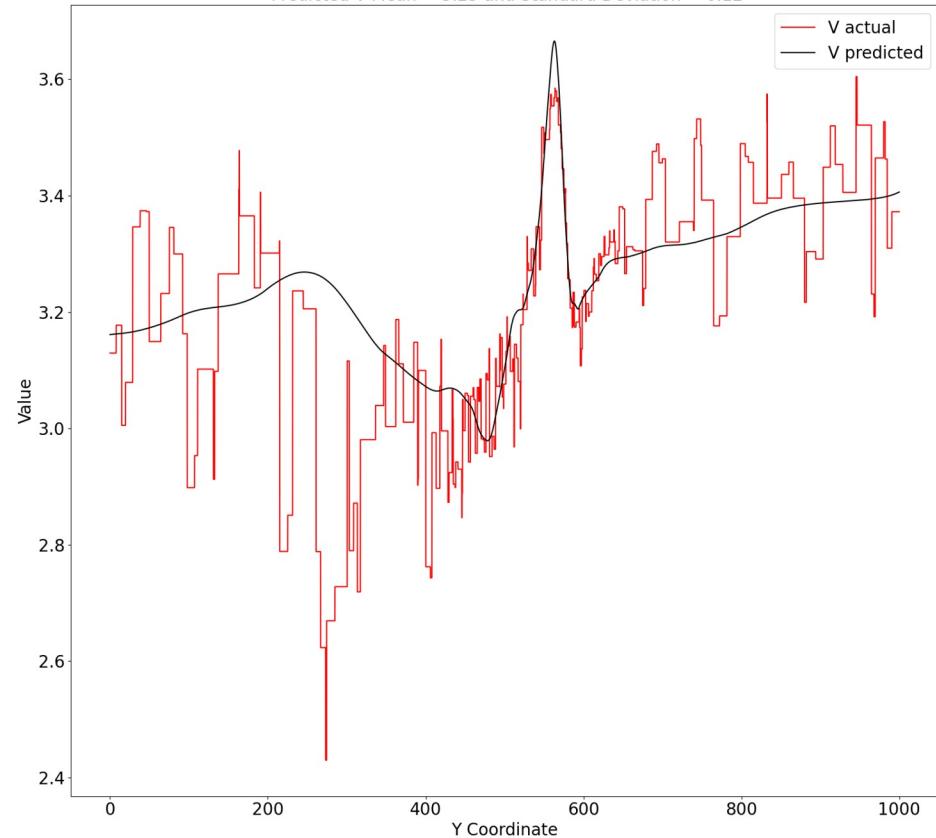
Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
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Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

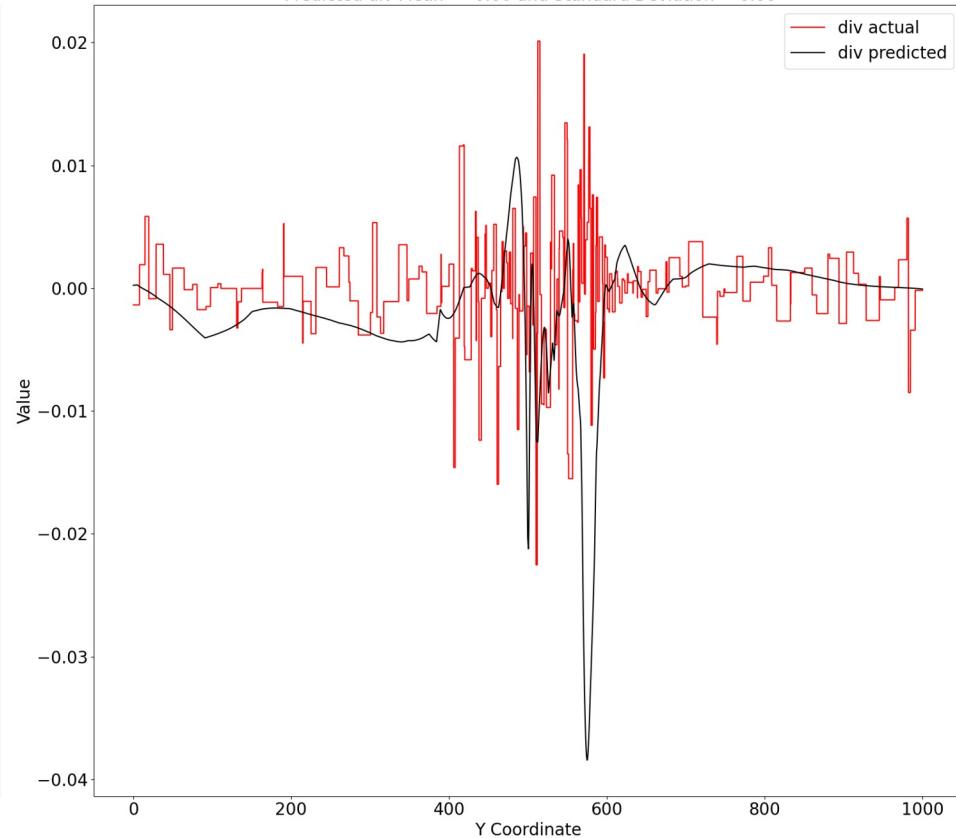
Scripts v5 – DIVERGENCE LINE

Comparison of Actual vs. Predicted values with Wind Angle = 0

Actual and Predicted V for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual V Mean = 3.22 and Standard Deviation = 0.21
Predicted V Mean = 3.25 and Standard Deviation = 0.12

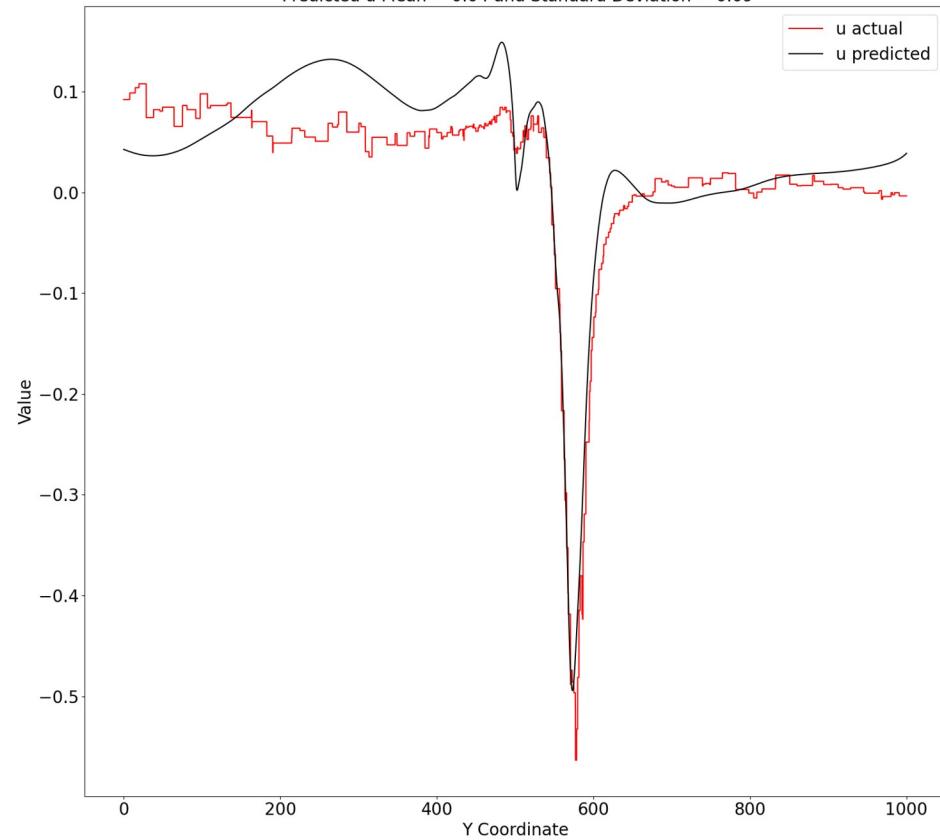


Actual and Predicted div for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.00
Predicted div Mean = -0.00 and Standard Deviation = 0.00

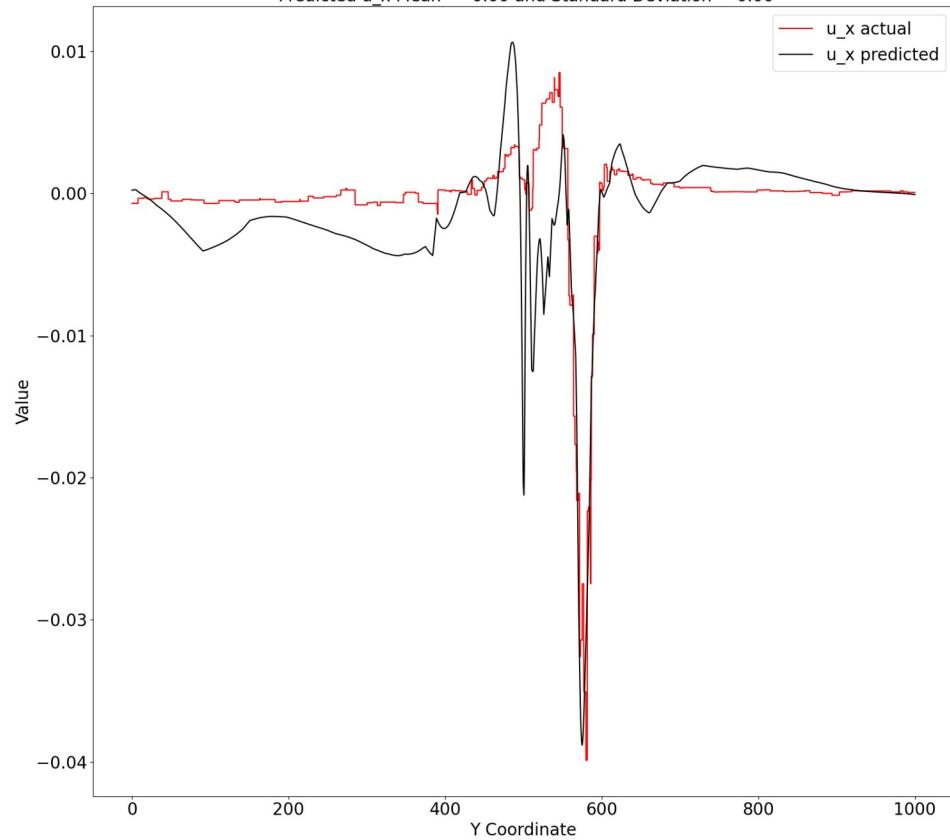


Comparison of Actual vs. Predicted values with Wind Angle = 0

Actual and Predicted u for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual u Mean = 0.02 and Standard Deviation = 0.09
Predicted u Mean = 0.04 and Standard Deviation = 0.09

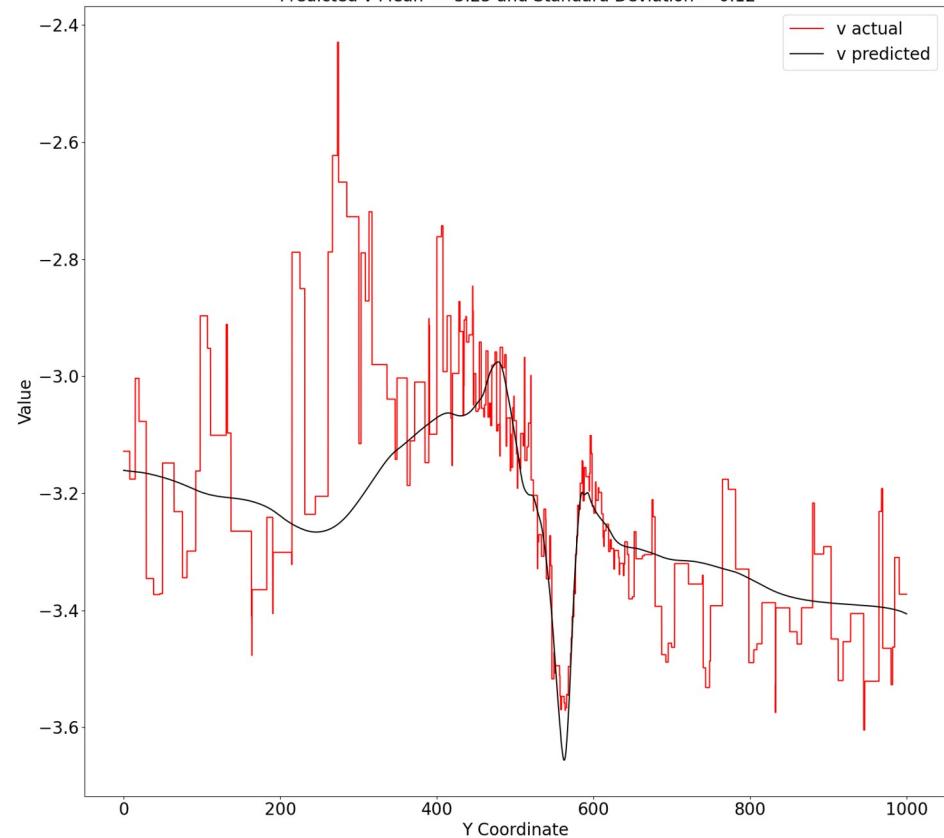


Actual and Predicted u_x for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual u_x Mean = -0.00 and Standard Deviation = 0.00
Predicted u_x Mean = -0.00 and Standard Deviation = 0.00

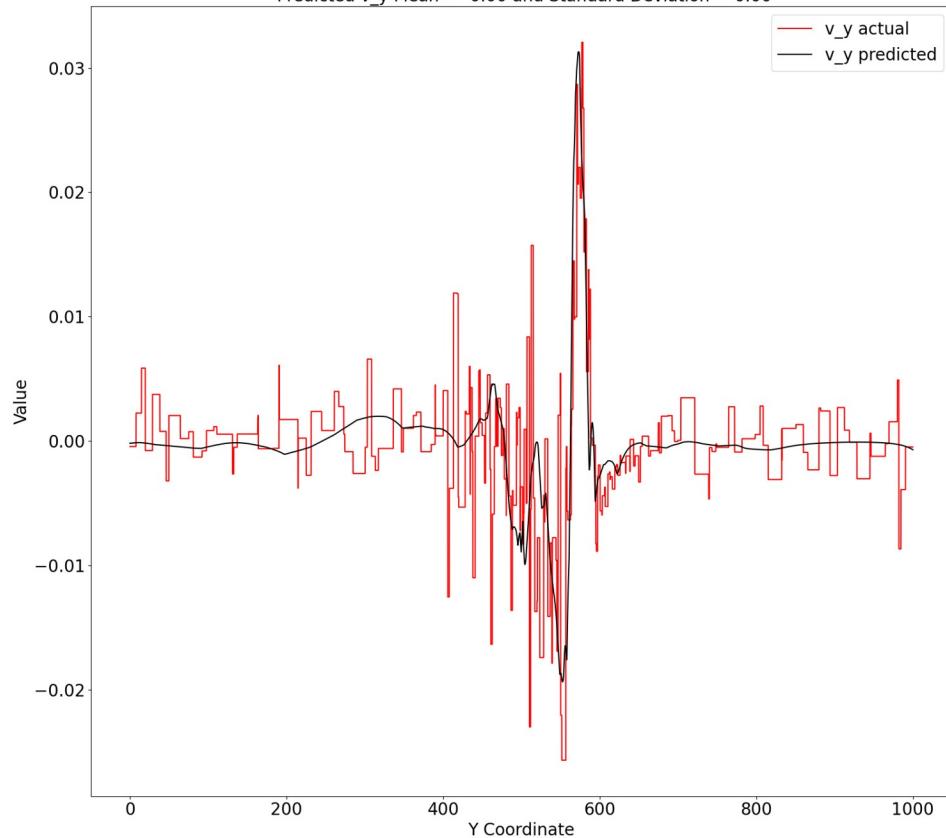


Comparison of Actual vs. Predicted values with Wind Angle = 0

Actual and Predicted v for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual v Mean = -3.21 and Standard Deviation = 0.21
Predicted v Mean = -3.25 and Standard Deviation = 0.12

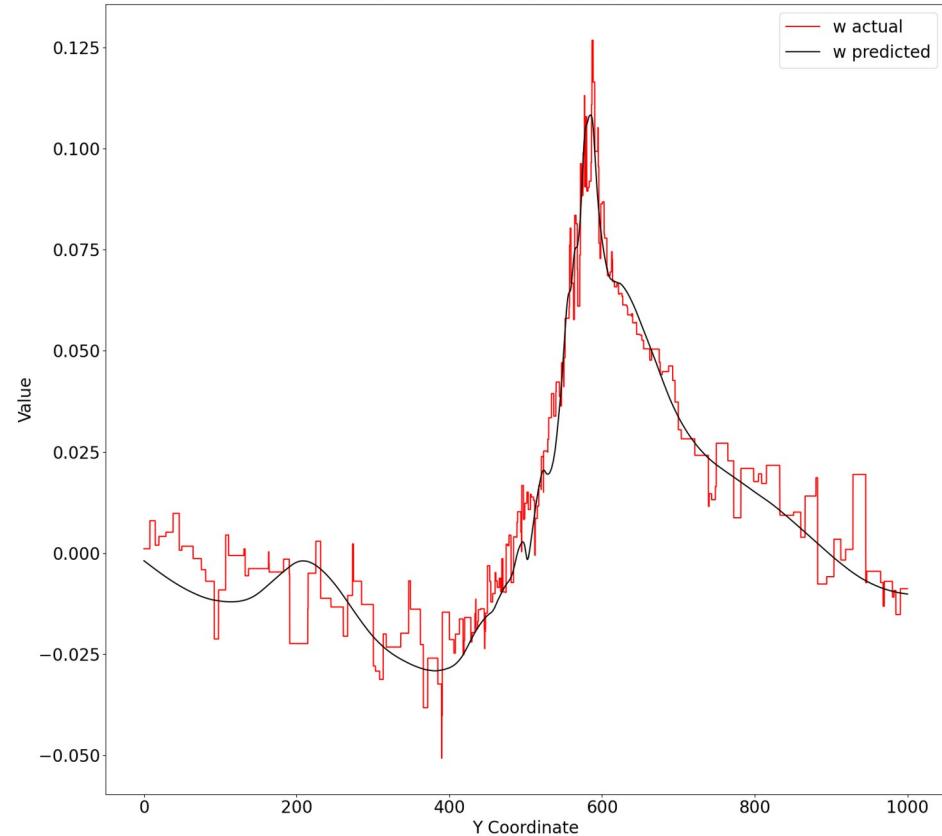


Actual and Predicted v_y for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.01
Predicted v_y Mean = -0.00 and Standard Deviation = 0.00

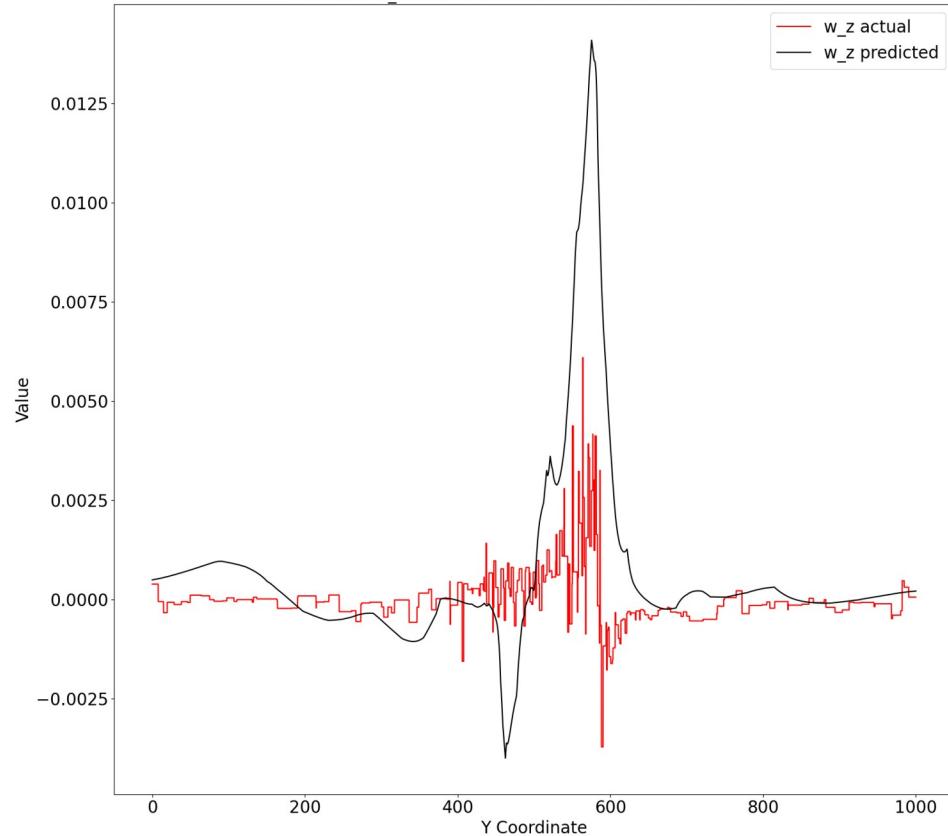


Comparison of Actual vs. Predicted values with Wind Angle = 0

Actual and Predicted w for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual w Mean = 0.01 and Standard Deviation = 0.03
Predicted w Mean = 0.01 and Standard Deviation = 0.03

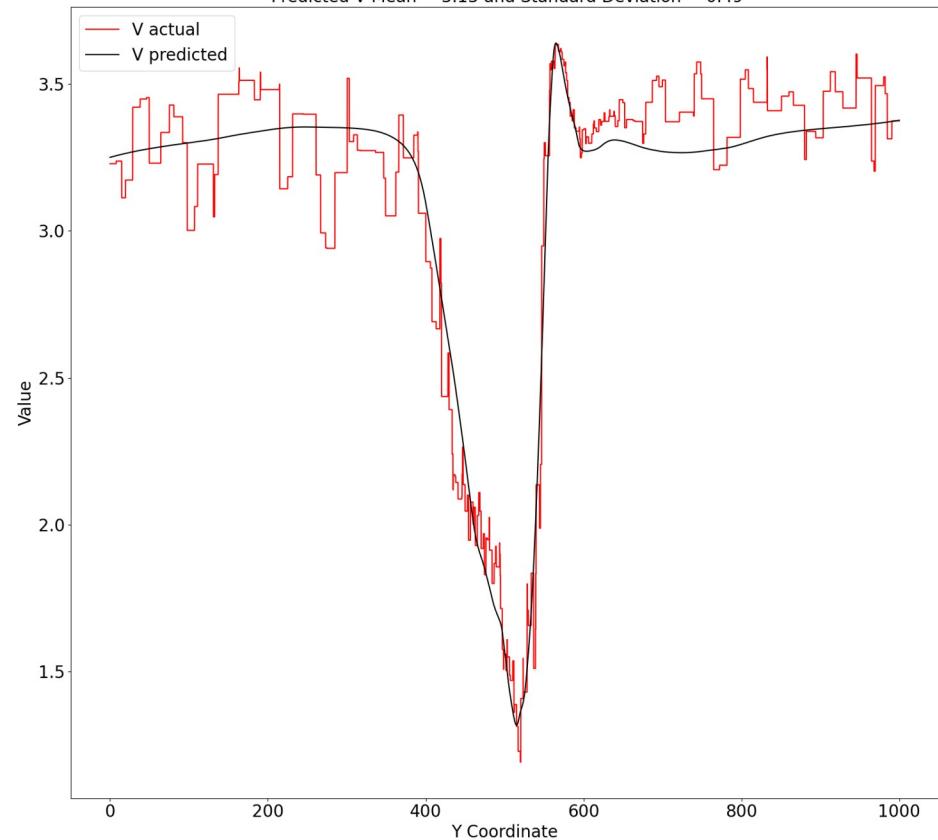


Actual and Predicted w_z for Wind Angle = 0 with a cut at Z=50m and X=480m
Actual w_z Mean = -0.00 and Standard Deviation = 0.00
Predicted w_z Mean = 0.00 and Standard Deviation = 0.00

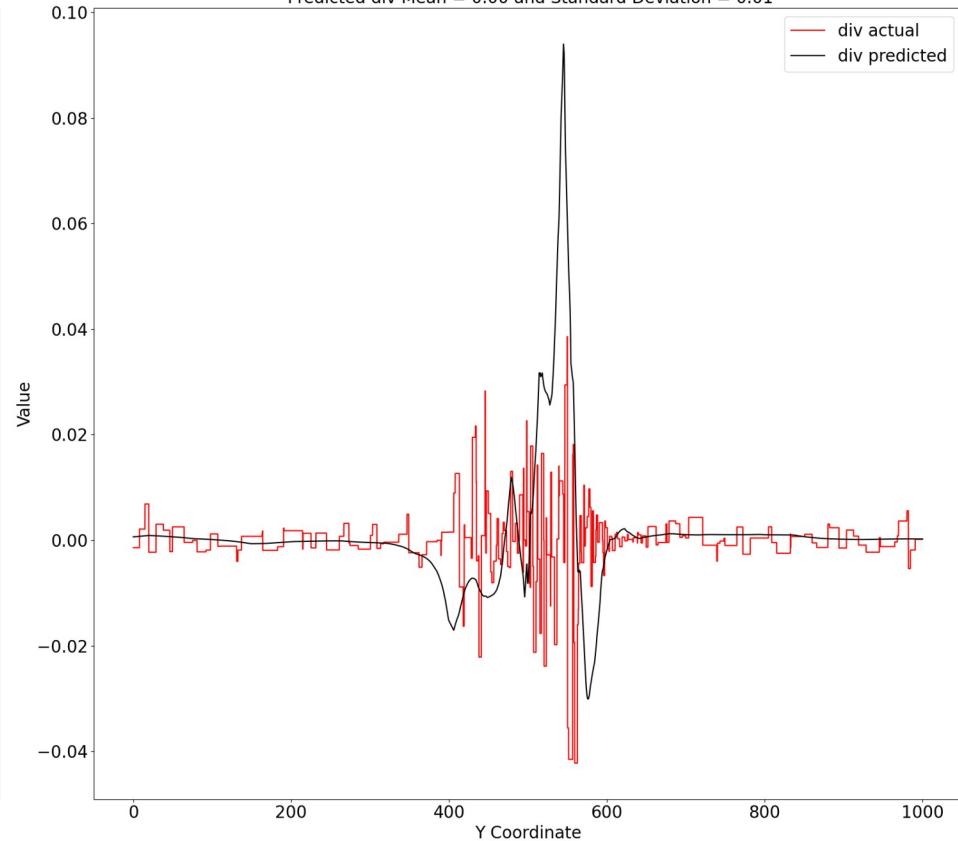


Comparison of Actual vs. Predicted values with Wind Angle = 15

Actual and Predicted V for Wind Angle = 15 with a cut at Z=50m and X=480m
Actual V Mean = 3.16 and Standard Deviation = 0.52
Predicted V Mean = 3.13 and Standard Deviation = 0.49



Actual and Predicted div for Wind Angle = 15 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.01

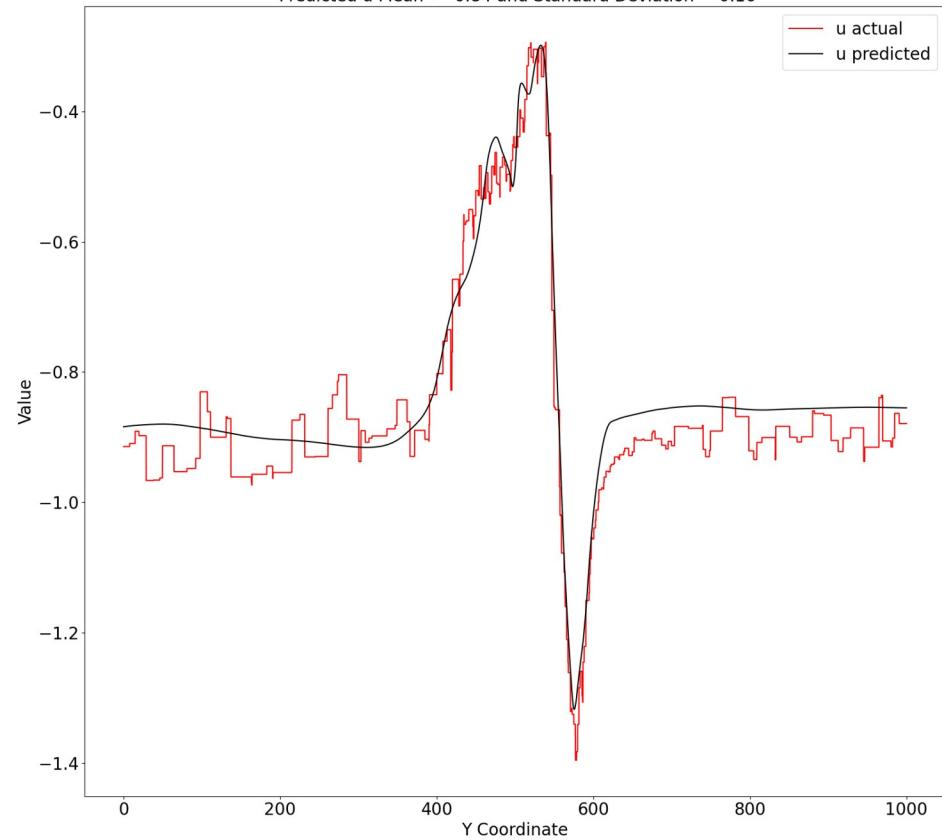


Comparison of Actual vs. Predicted values with Wind Angle = 15

Actual and Predicted u for Wind Angle = 15 with a cut at Z=50m and X=480m

Actual u Mean = -0.86 and Standard Deviation = 0.17

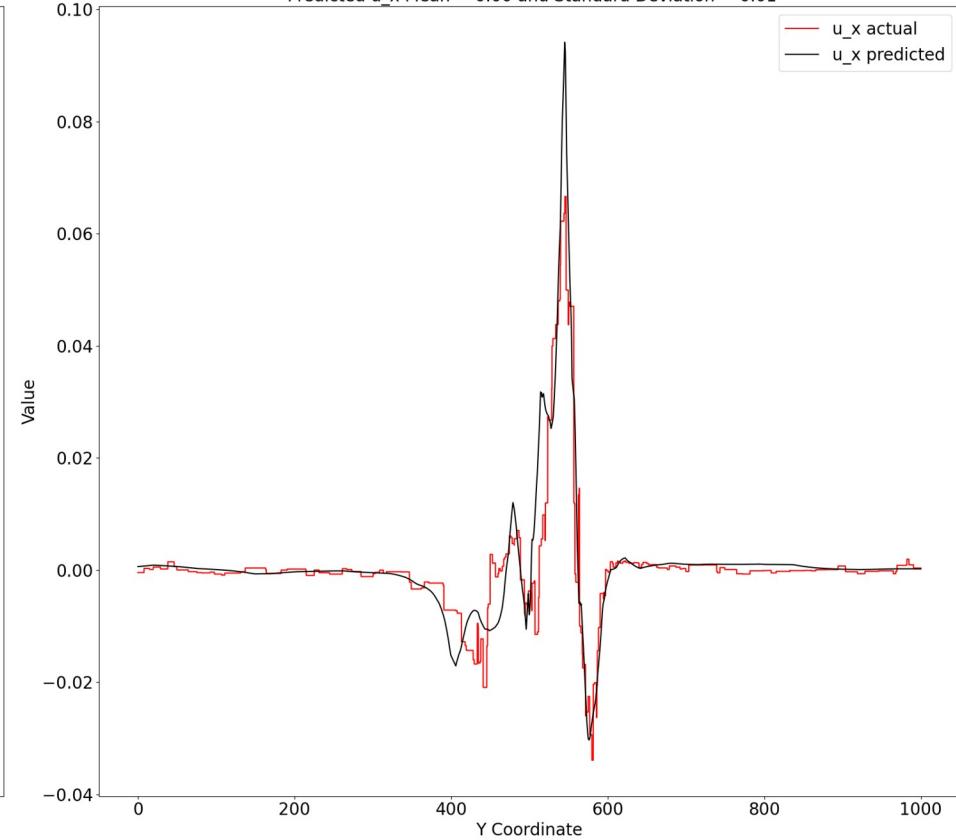
Predicted u Mean = -0.84 and Standard Deviation = 0.16



Actual and Predicted u_x for Wind Angle = 15 with a cut at Z=50m and X=480m

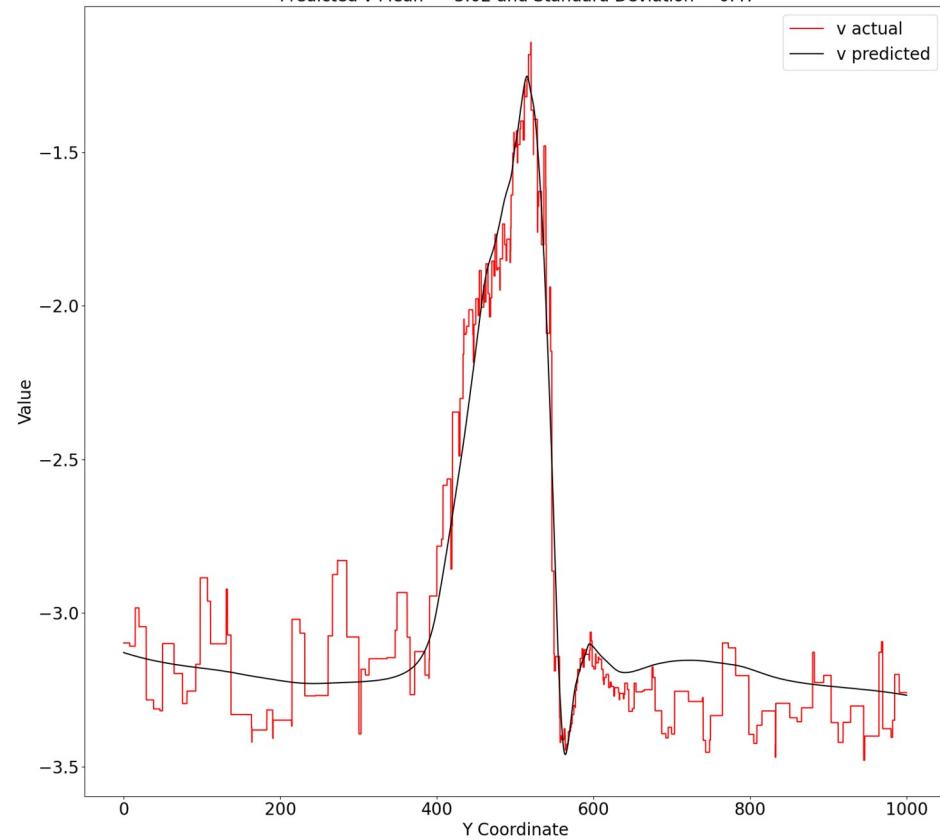
Actual u_x Mean = 0.00 and Standard Deviation = 0.01

Predicted u_x Mean = 0.00 and Standard Deviation = 0.01

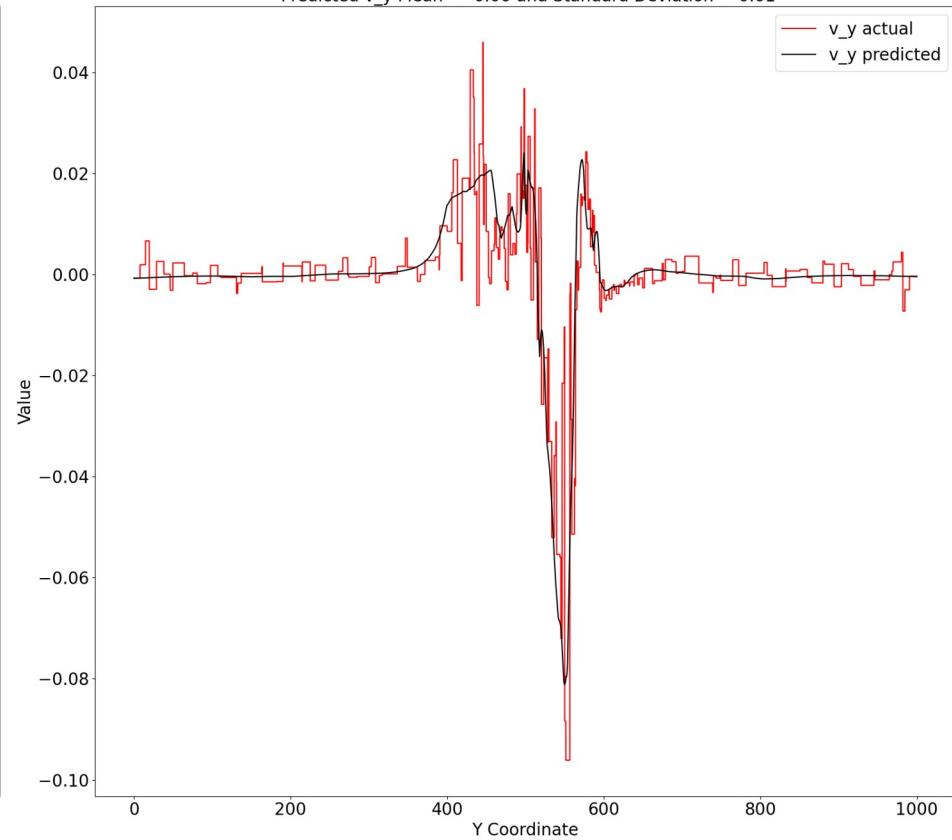


Comparison of Actual vs. Predicted values with Wind Angle = 15

Actual and Predicted v for Wind Angle = 15 with a cut at Z=50m and X=480m
 Actual v Mean = -3.04 and Standard Deviation = 0.50
 Predicted v Mean = -3.02 and Standard Deviation = 0.47



Actual and Predicted v_y for Wind Angle = 15 with a cut at Z=50m and X=480m
 Actual v_y Mean = -0.00 and Standard Deviation = 0.01
 Predicted v_y Mean = -0.00 and Standard Deviation = 0.01

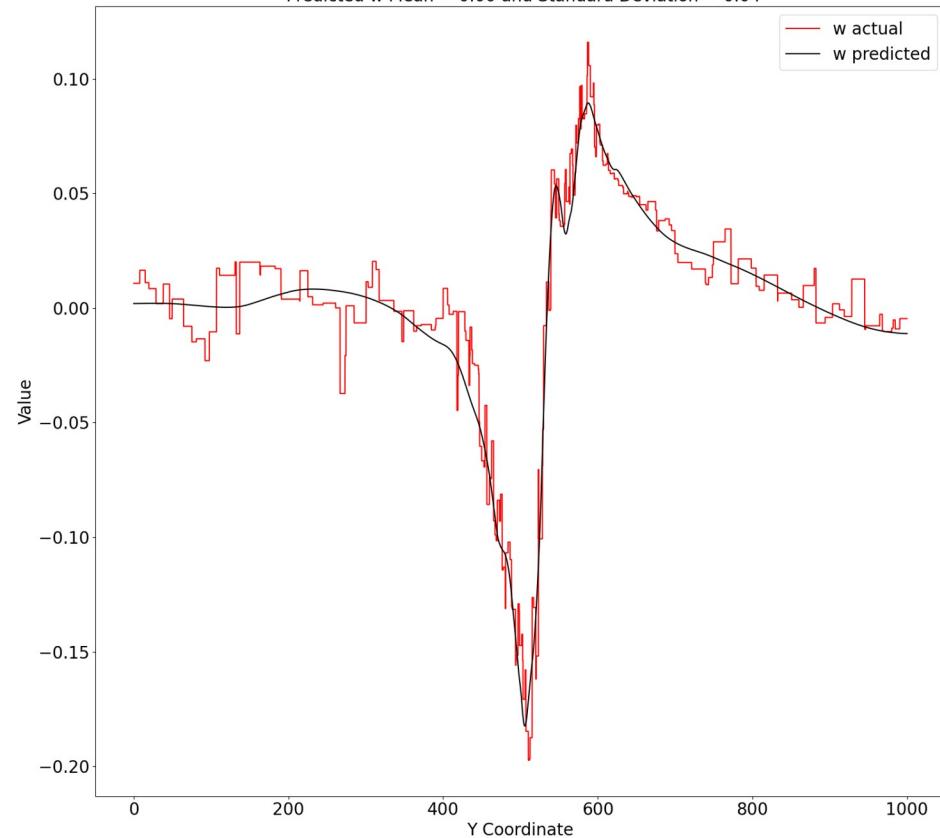


Comparison of Actual vs. Predicted values with Wind Angle = 15

Actual and Predicted w for Wind Angle = 15 with a cut at Z=50m and X=480m

Actual w Mean = 0.00 and Standard Deviation = 0.04

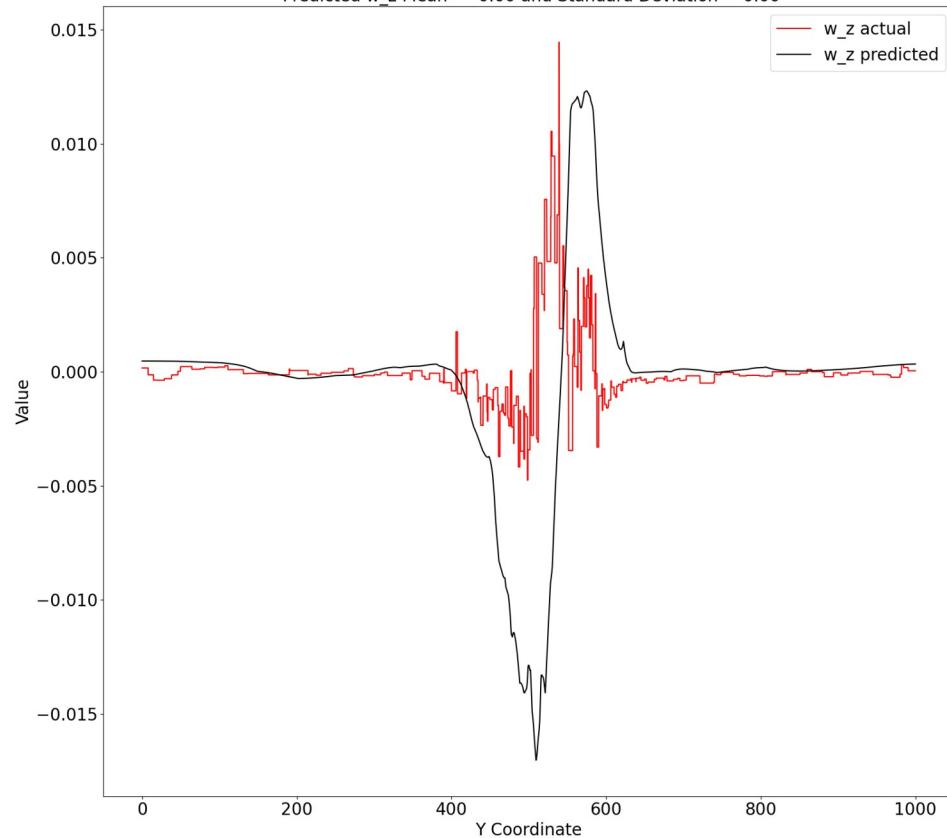
Predicted w Mean = 0.00 and Standard Deviation = 0.04



Actual and Predicted w_z for Wind Angle = 15 with a cut at Z=50m and X=480m

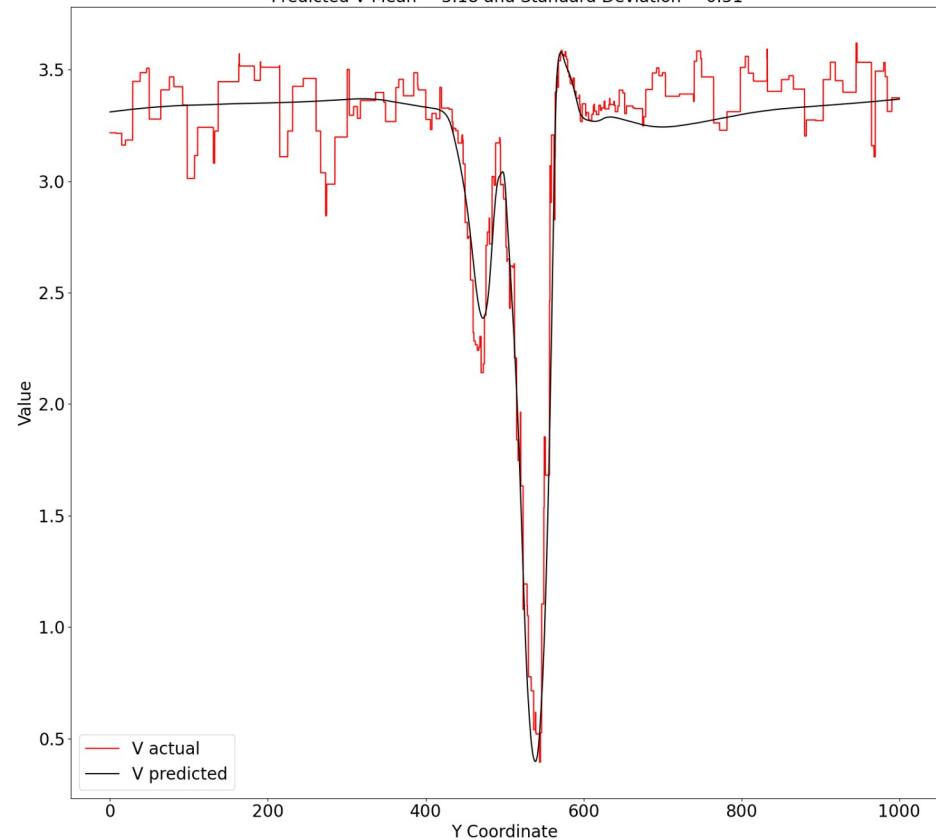
Actual w_z Mean = -0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

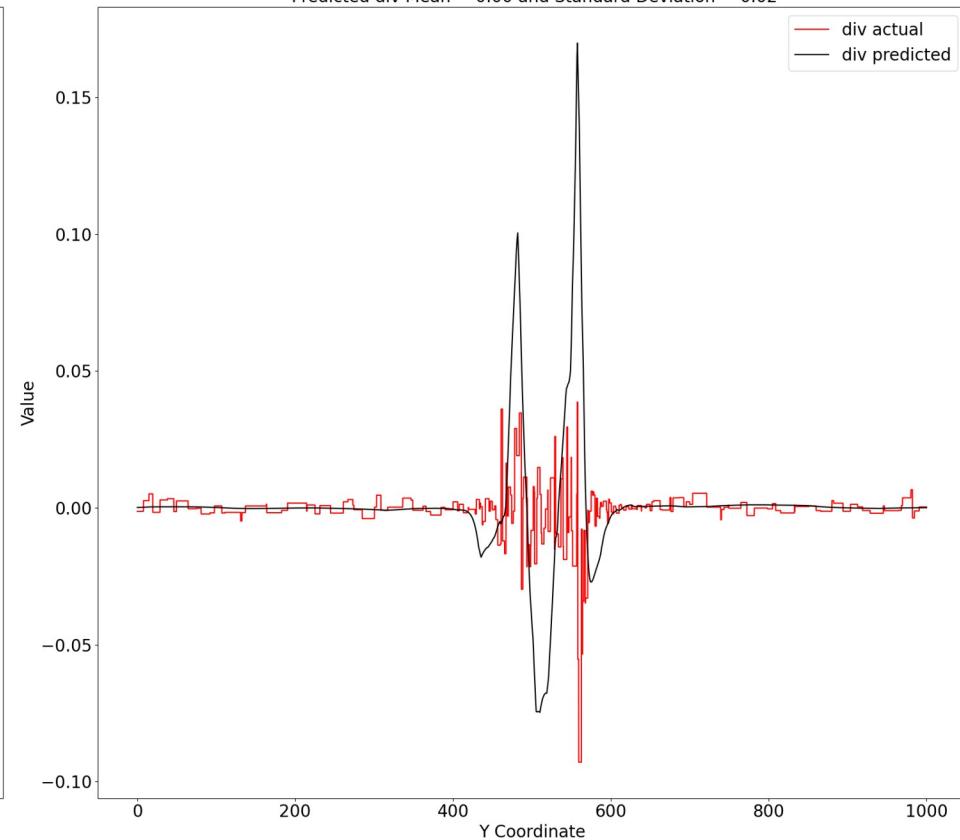


Comparison of Actual vs. Predicted values with Wind Angle = 30

Actual and Predicted V for Wind Angle = 30 with a cut at Z=50m and X=480m
Actual V Mean = 3.22 and Standard Deviation = 0.50
Predicted V Mean = 3.18 and Standard Deviation = 0.51



Actual and Predicted div for Wind Angle = 30 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.02

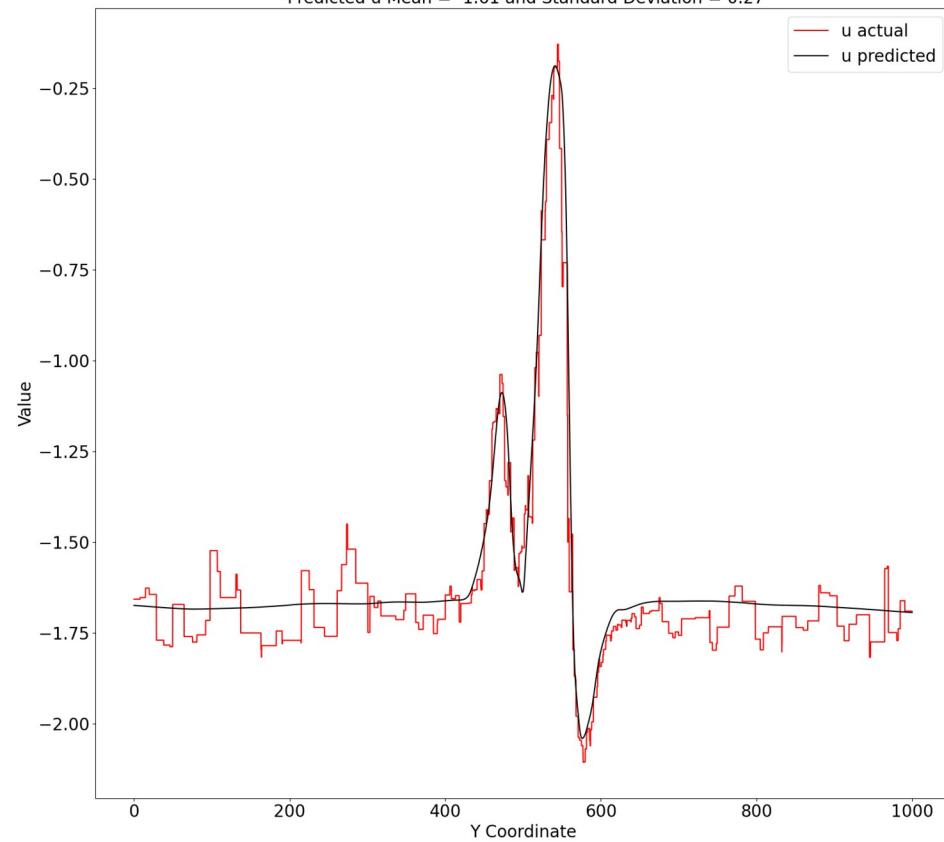


Comparison of Actual vs. Predicted values with Wind Angle = 30

Actual and Predicted u for Wind Angle = 30 with a cut at Z=50m and X=480m

Actual u Mean = -1.64 and Standard Deviation = 0.26

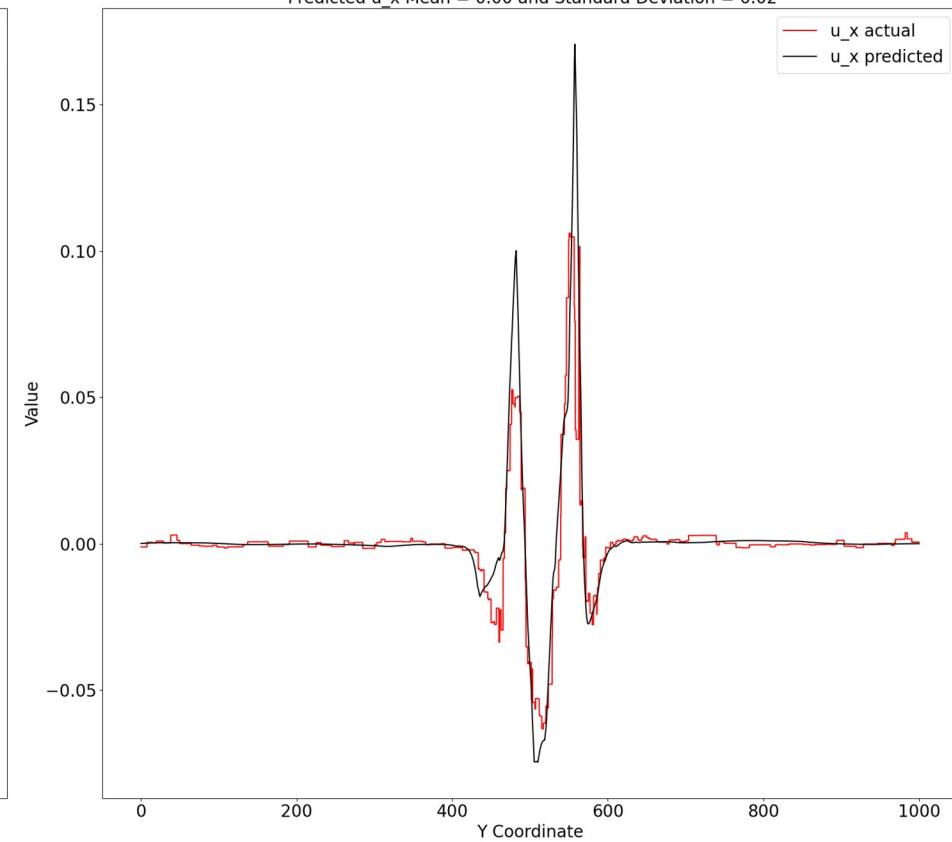
Predicted u Mean = -1.61 and Standard Deviation = 0.27



Actual and Predicted u_x for Wind Angle = 30 with a cut at Z=50m and X=480m

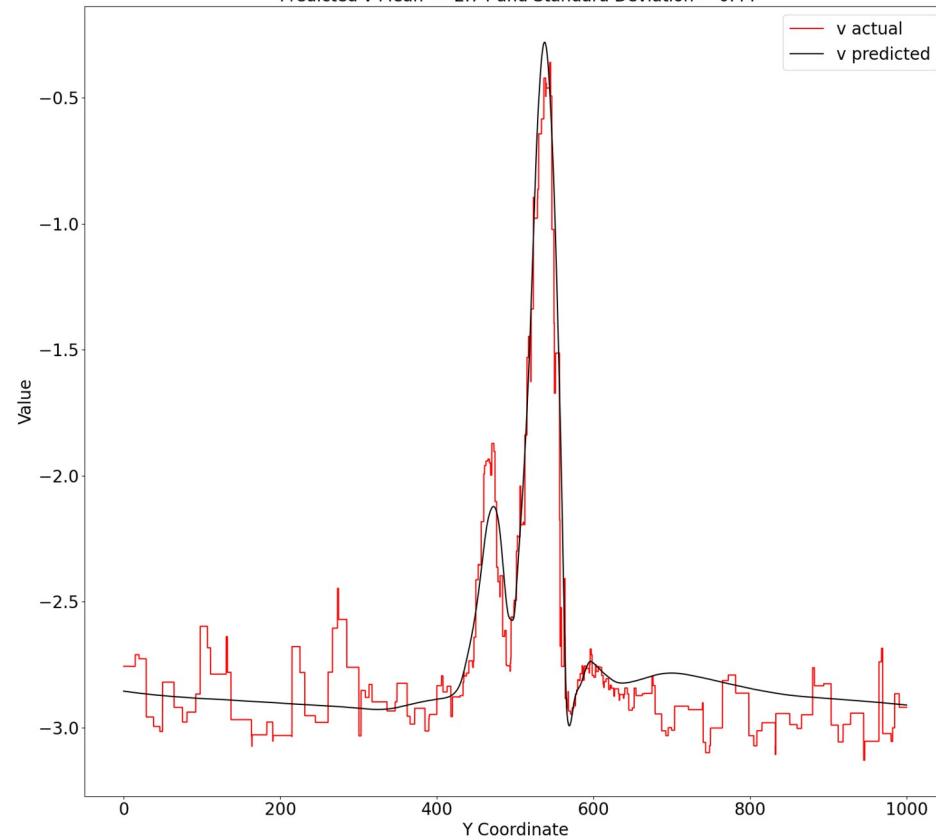
Actual u_x Mean = -0.00 and Standard Deviation = 0.02

Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

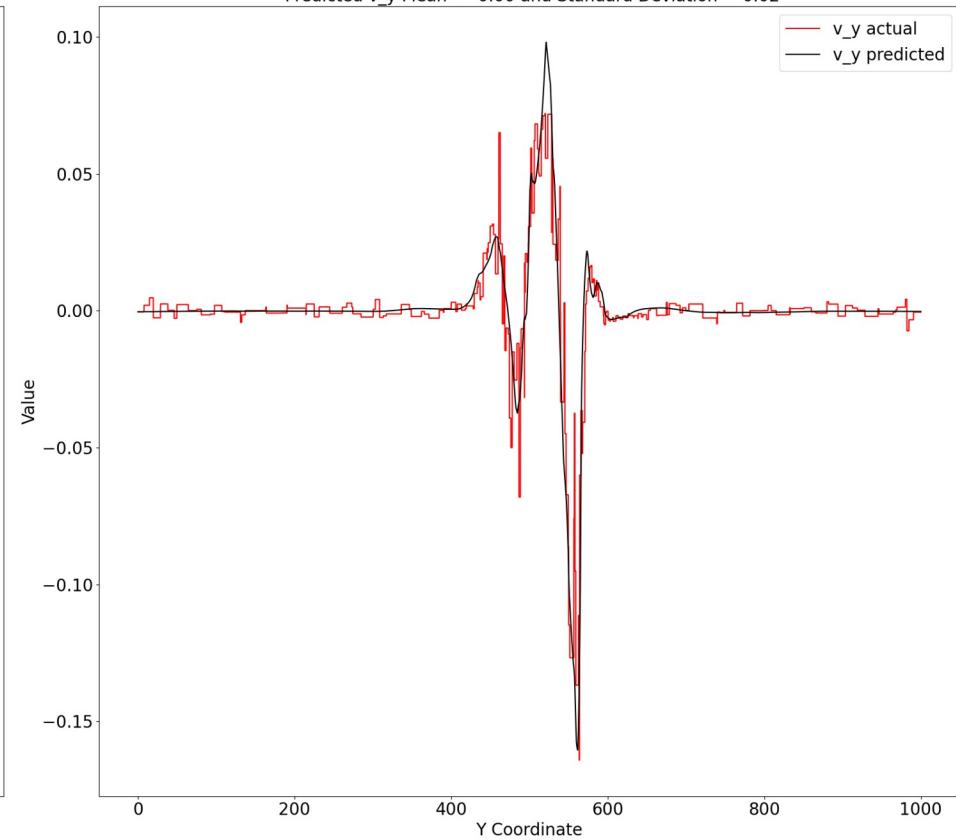


Comparison of Actual vs. Predicted values with Wind Angle = 30

Actual and Predicted v for Wind Angle = 30 with a cut at Z=50m and X=480m
 Actual v Mean = -2.77 and Standard Deviation = 0.43
 Predicted v Mean = -2.74 and Standard Deviation = 0.44



Actual and Predicted v_y for Wind Angle = 30 with a cut at Z=50m and X=480m
 Actual v_y Mean = -0.00 and Standard Deviation = 0.02
 Predicted v_y Mean = -0.00 and Standard Deviation = 0.02

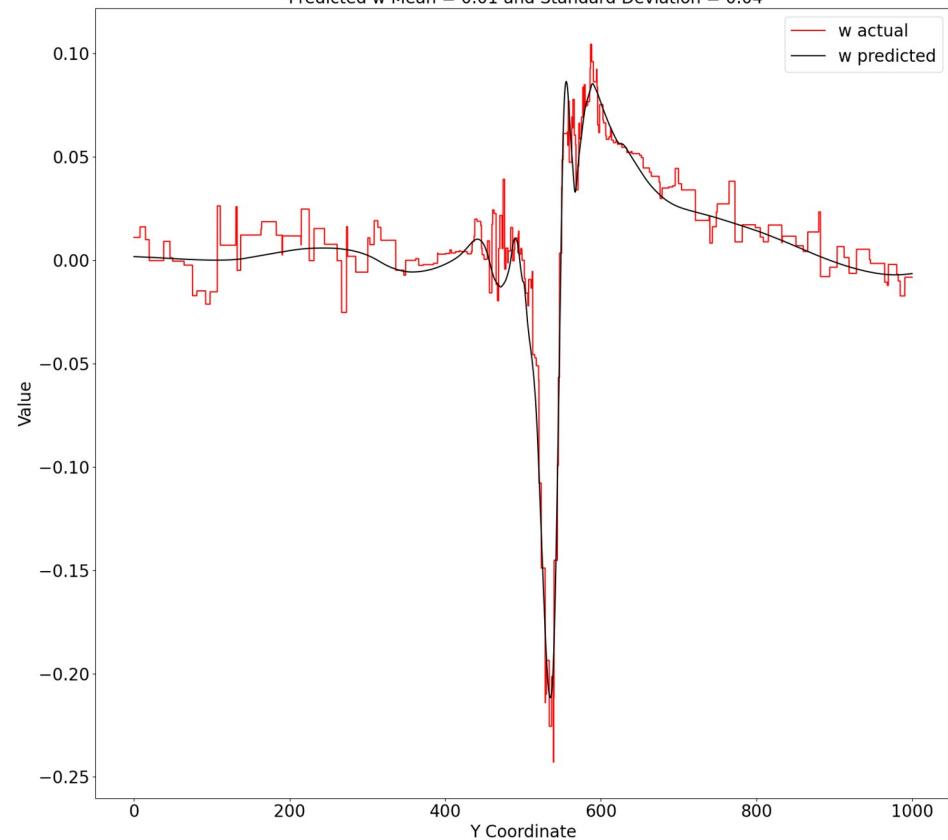


Comparison of Actual vs. Predicted values with Wind Angle = 30

Actual and Predicted w for Wind Angle = 30 with a cut at Z=50m and X=480m

Actual w Mean = 0.01 and Standard Deviation = 0.04

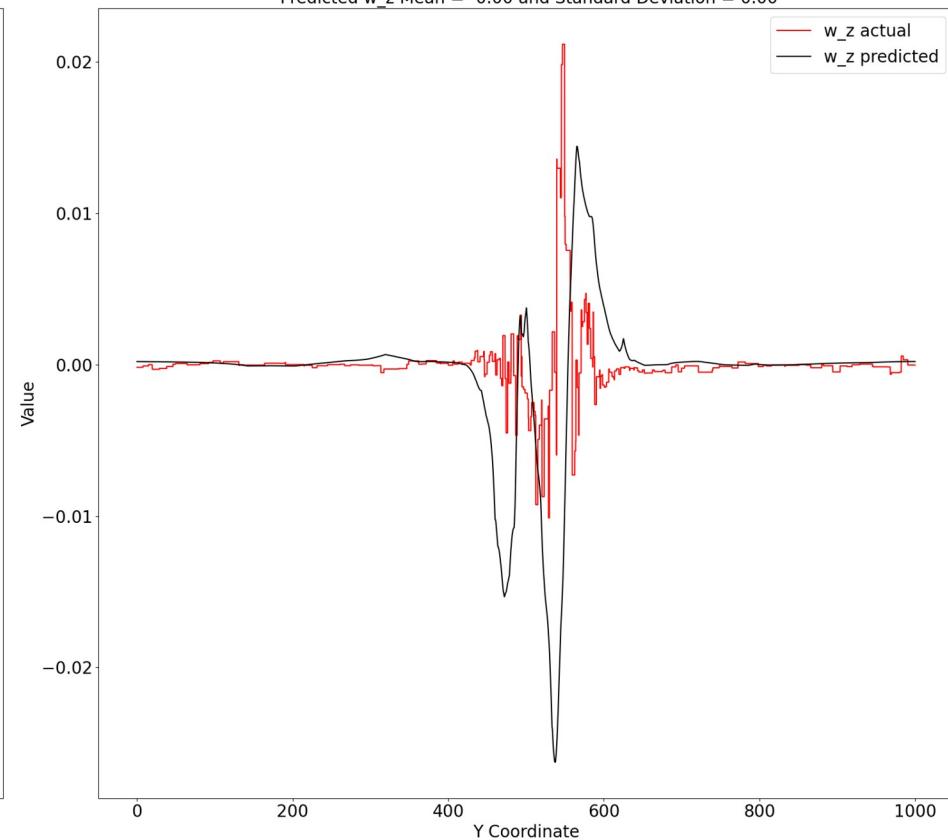
Predicted w Mean = 0.01 and Standard Deviation = 0.04



Actual and Predicted w_z for Wind Angle = 30 with a cut at Z=50m and X=480m

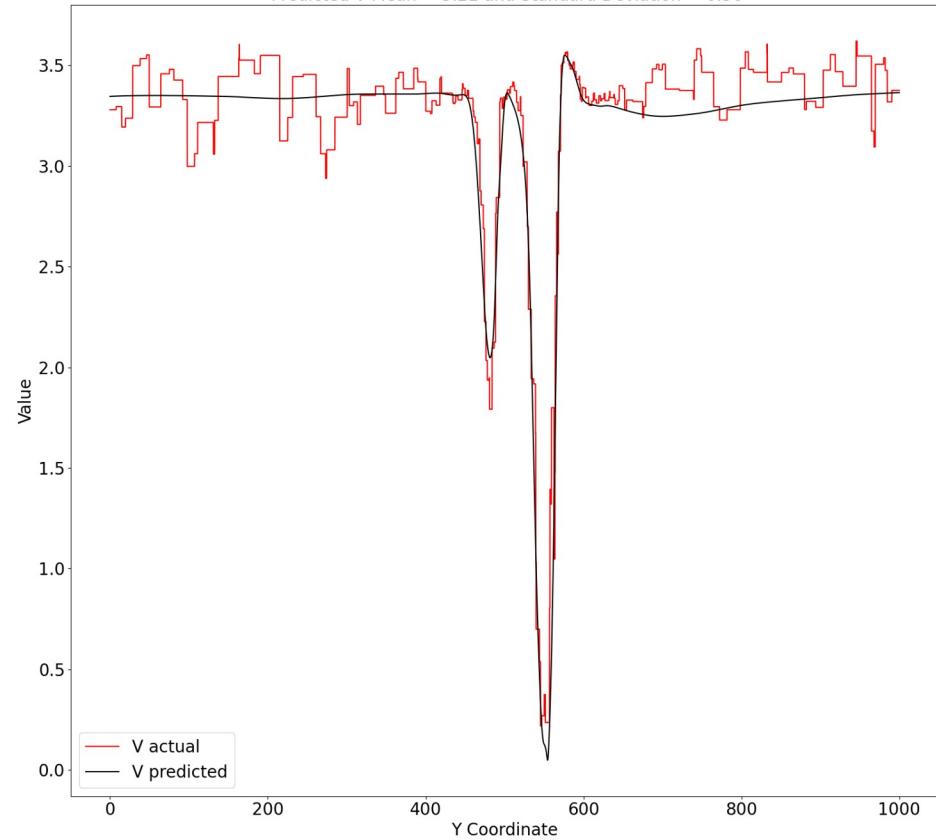
Actual w_z Mean = -0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

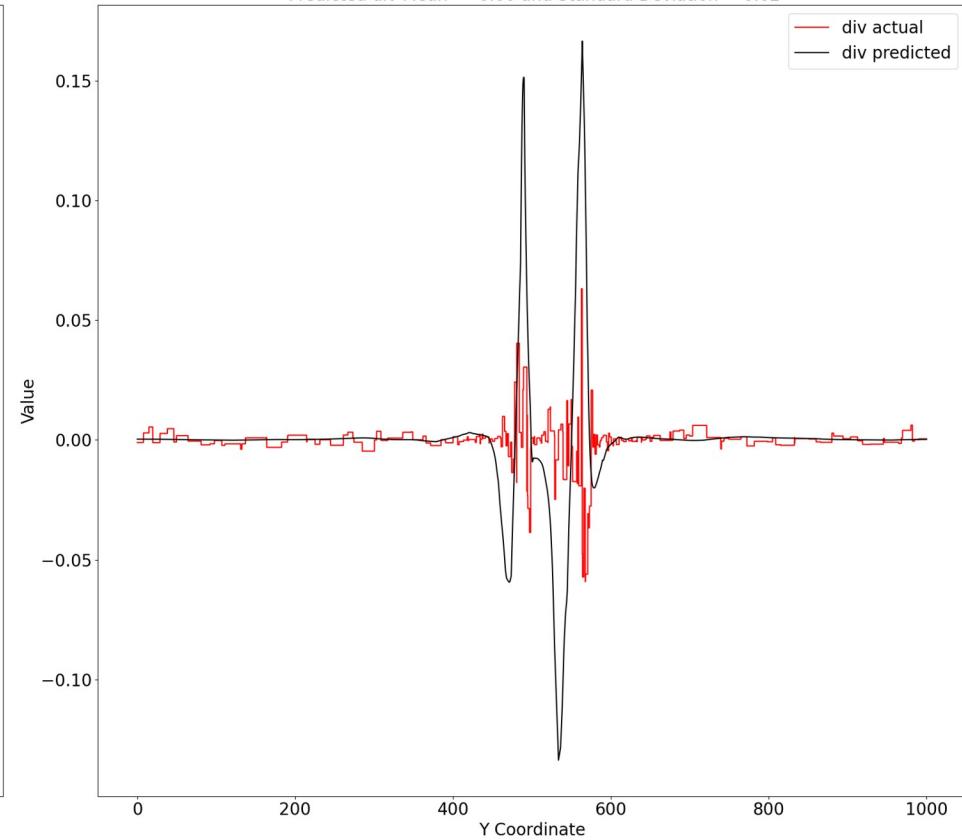


Comparison of Actual vs. Predicted values with Wind Angle = 45

Actual and Predicted V for Wind Angle = 45 with a cut at Z=50m and X=480m
Actual V Mean = 3.26 and Standard Deviation = 0.48
Predicted V Mean = 3.21 and Standard Deviation = 0.50



Actual and Predicted div for Wind Angle = 45 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.01
Predicted div Mean = -0.00 and Standard Deviation = 0.02

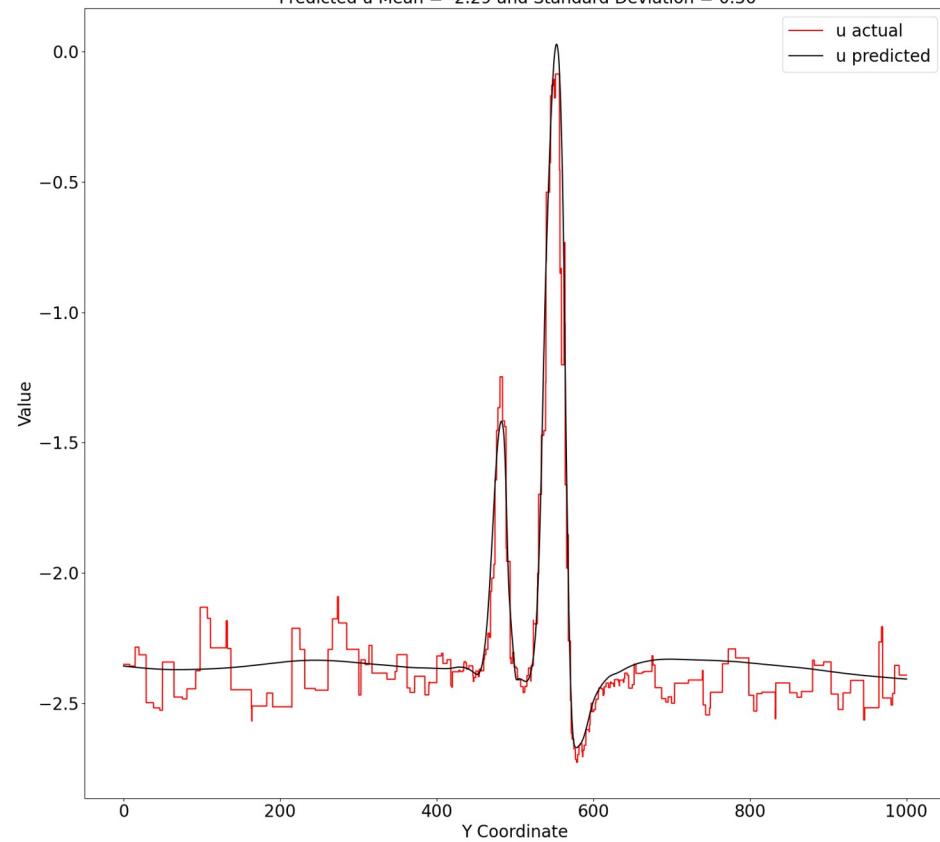


Comparison of Actual vs. Predicted values with Wind Angle = 45

Actual and Predicted u for Wind Angle = 45 with a cut at Z=50m and X=480m

Actual u Mean = -2.33 and Standard Deviation = 0.35

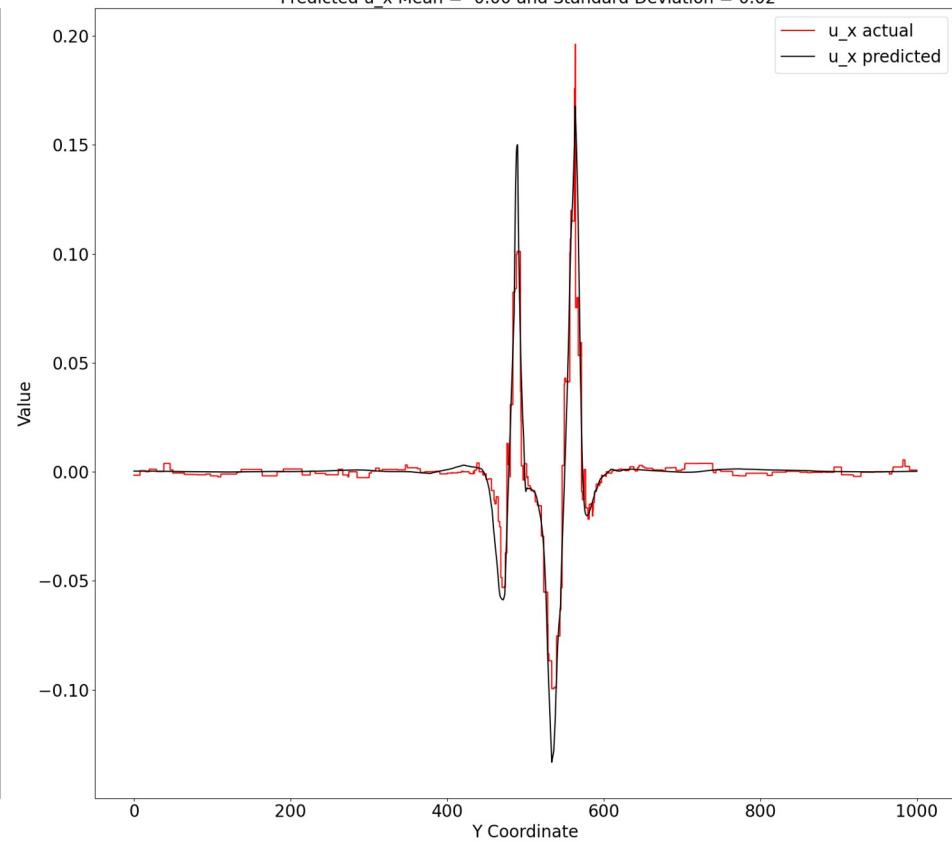
Predicted u Mean = -2.29 and Standard Deviation = 0.36



Actual and Predicted u_x for Wind Angle = 45 with a cut at Z=50m and X=480m

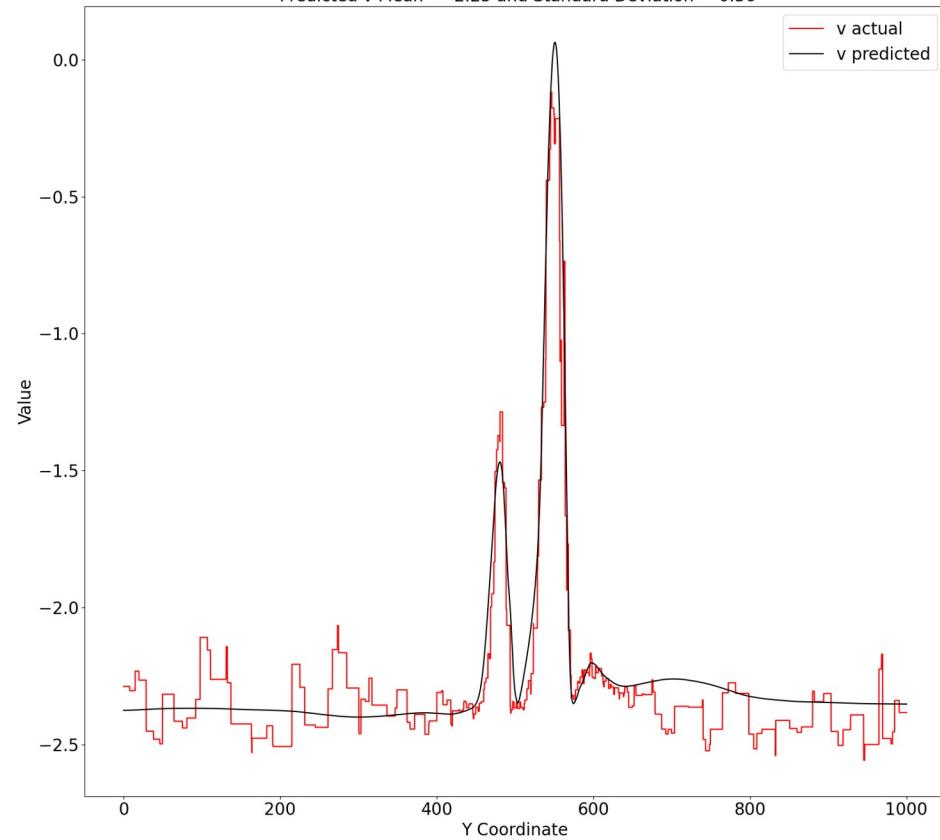
Actual u_x Mean = 0.00 and Standard Deviation = 0.02

Predicted u_x Mean = -0.00 and Standard Deviation = 0.02

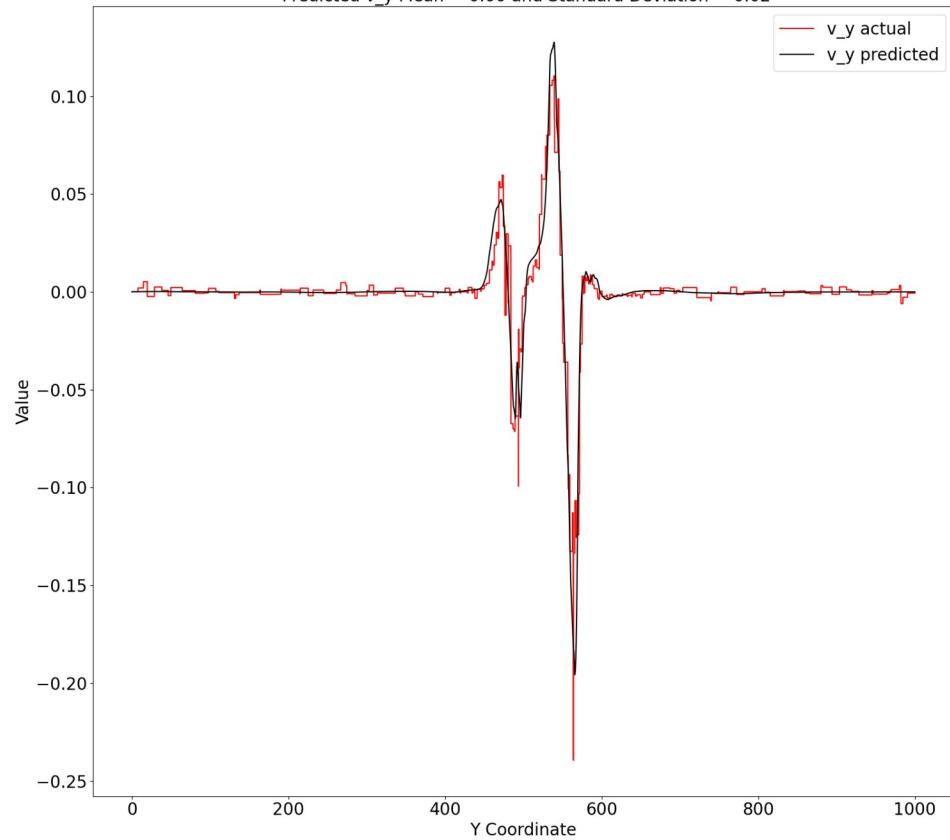


Comparison of Actual vs. Predicted values with Wind Angle = 45

Actual and Predicted v for Wind Angle = 45 with a cut at Z=50m and X=480m
 Actual v Mean = -2.29 and Standard Deviation = 0.34
 Predicted v Mean = -2.25 and Standard Deviation = 0.36

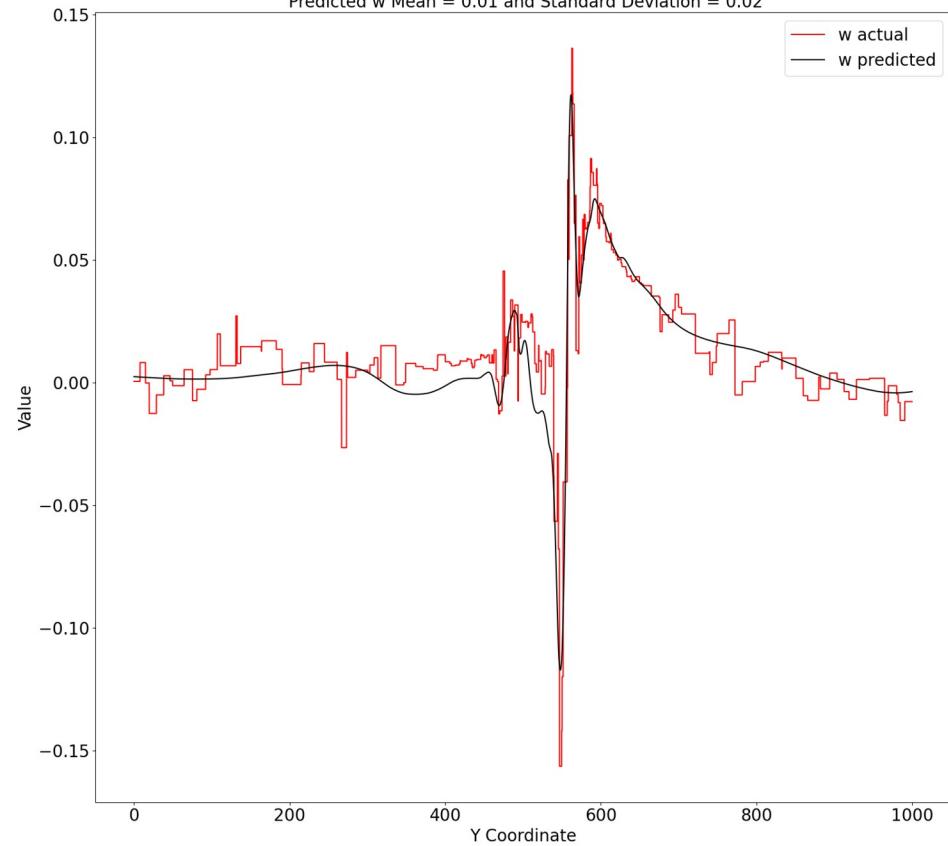


Actual and Predicted v_y for Wind Angle = 45 with a cut at Z=50m and X=480m
 Actual v_y Mean = -0.00 and Standard Deviation = 0.02
 Predicted v_y Mean = 0.00 and Standard Deviation = 0.02

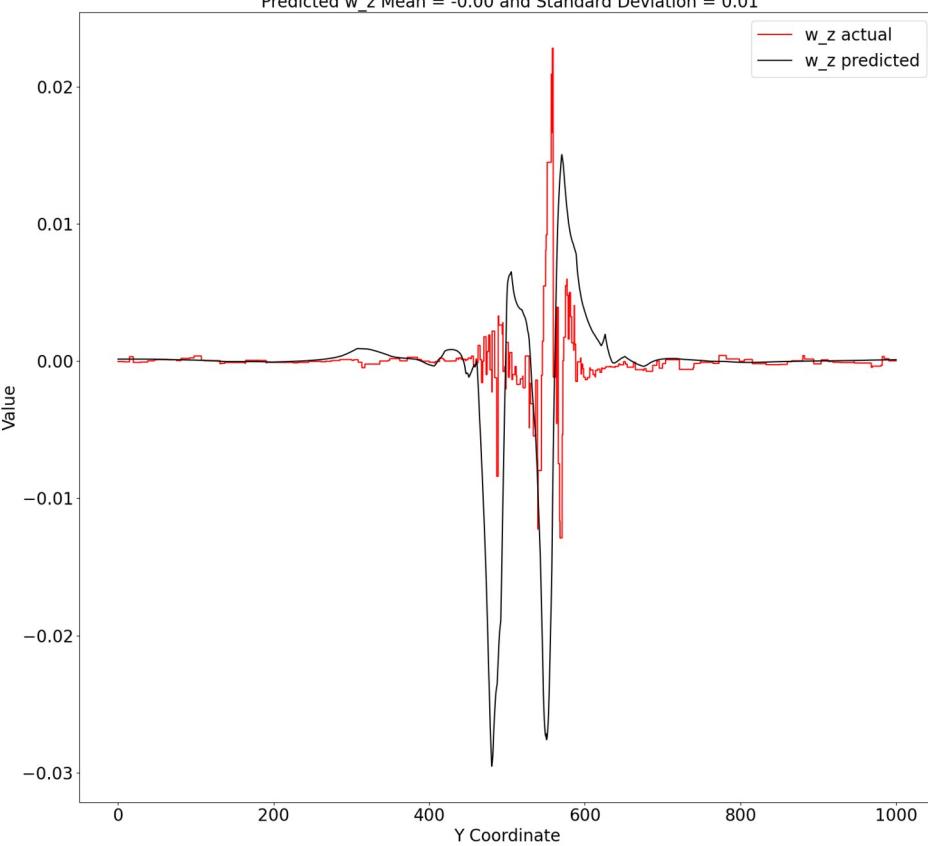


Comparison of Actual vs. Predicted values with Wind Angle = 45

Actual and Predicted w for Wind Angle = 45 with a cut at Z=50m and X=480m
Actual w Mean = 0.01 and Standard Deviation = 0.02
Predicted w Mean = 0.01 and Standard Deviation = 0.02

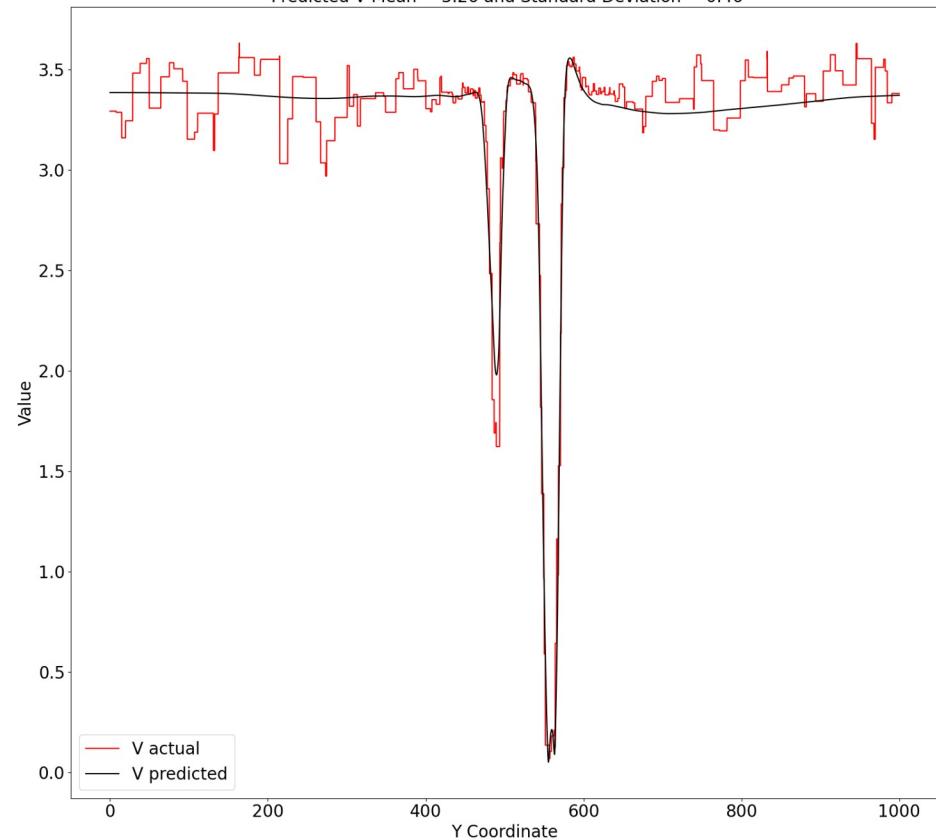


Actual and Predicted w_z for Wind Angle = 45 with a cut at Z=50m and X=480m
Actual w_z Mean = -0.00 and Standard Deviation = 0.00
Predicted w_z Mean = -0.00 and Standard Deviation = 0.01

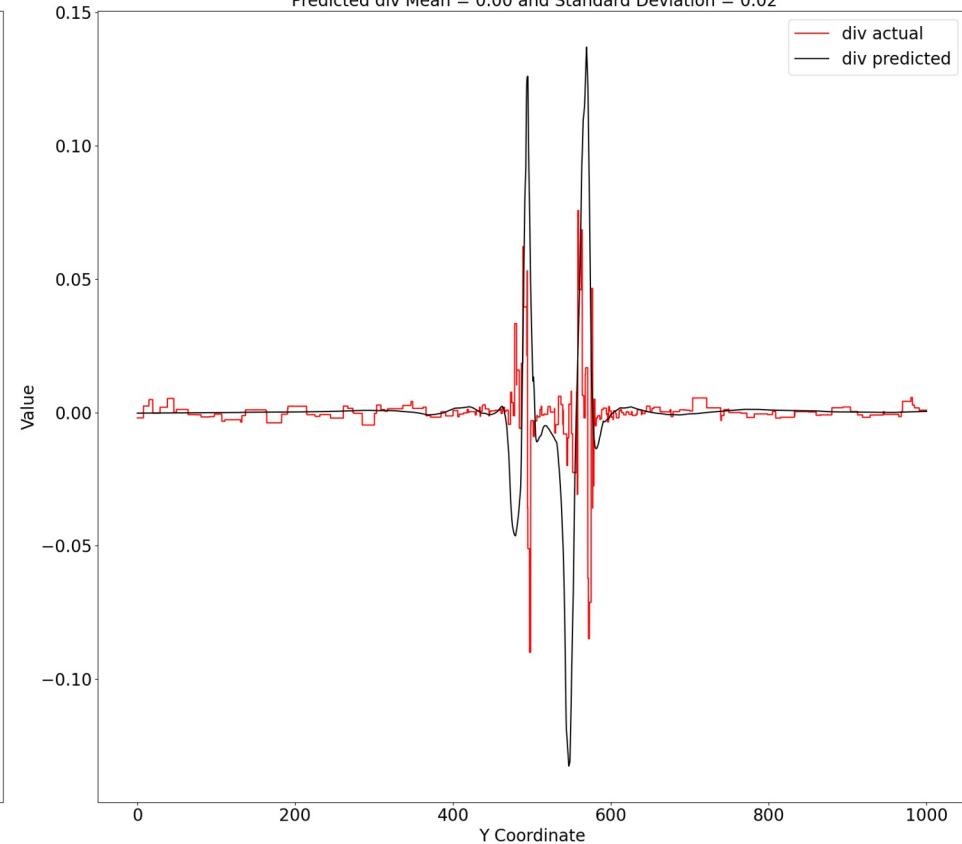


Comparison of Actual vs. Predicted values with Wind Angle = 60

Actual and Predicted V for Wind Angle = 60 with a cut at Z=50m and X=480m
Actual V Mean = 3.29 and Standard Deviation = 0.48
Predicted V Mean = 3.26 and Standard Deviation = 0.46

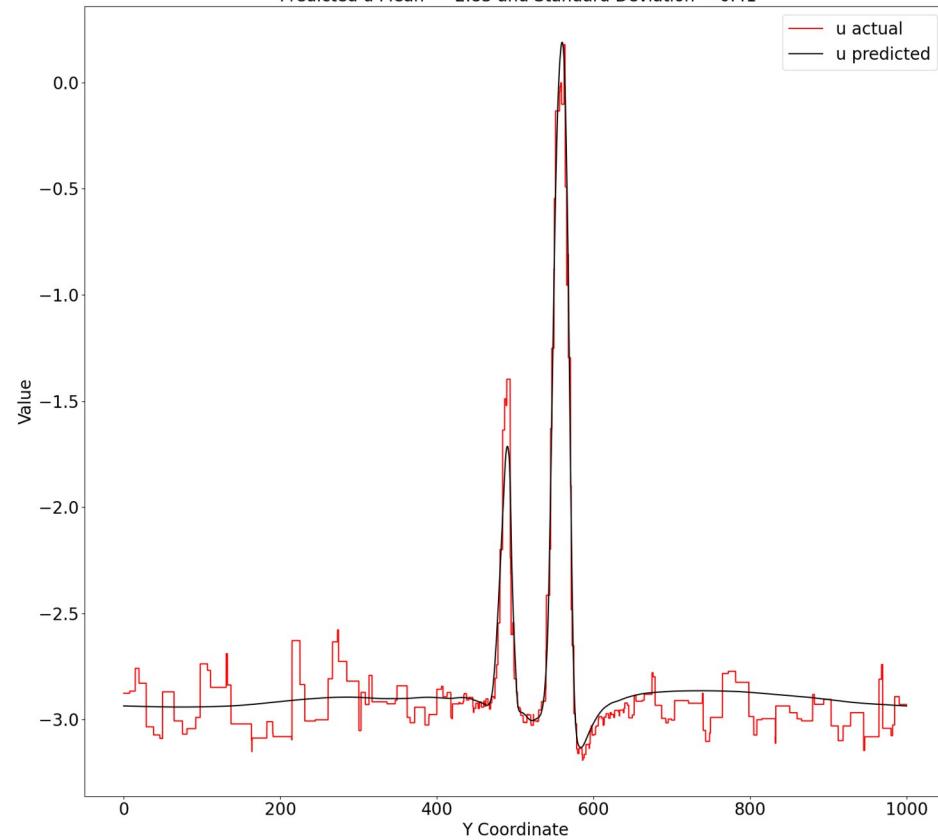


Actual and Predicted div for Wind Angle = 60 with a cut at Z=50m and X=480m
Actual div Mean = 0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.02

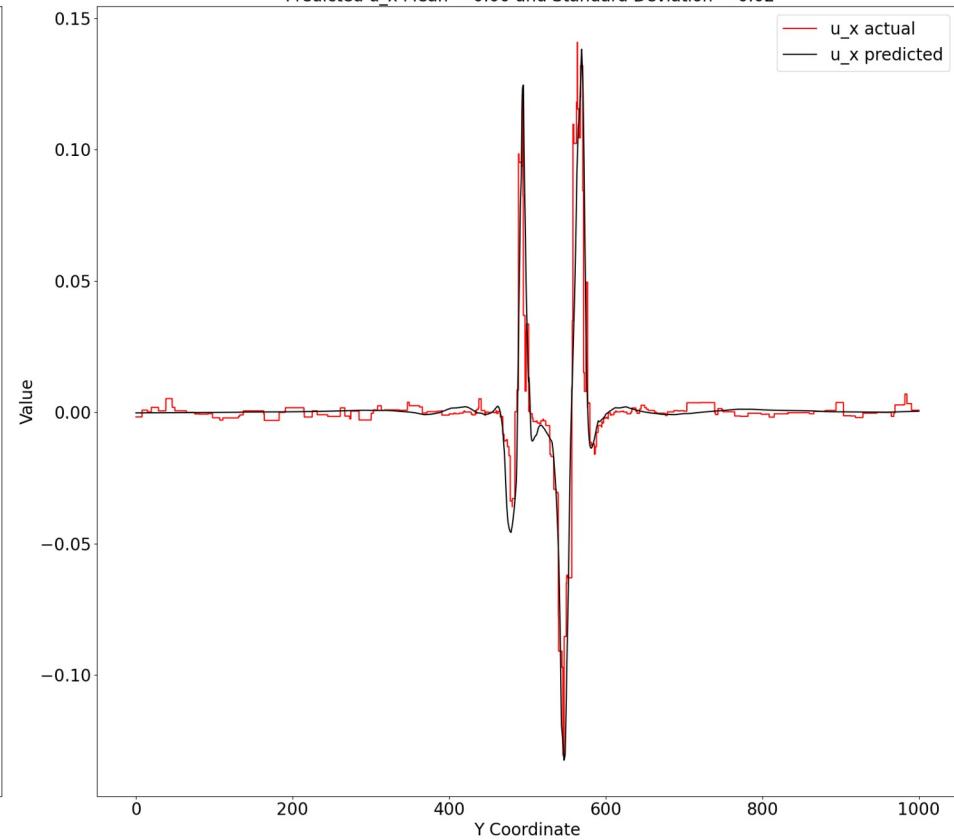


Comparison of Actual vs. Predicted values with Wind Angle = 60

Actual and Predicted u for Wind Angle = 60 with a cut at Z=50m and X=480m
 Actual u Mean = -2.86 and Standard Deviation = 0.43
 Predicted u Mean = -2.83 and Standard Deviation = 0.41



Actual and Predicted u_x for Wind Angle = 60 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.02
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

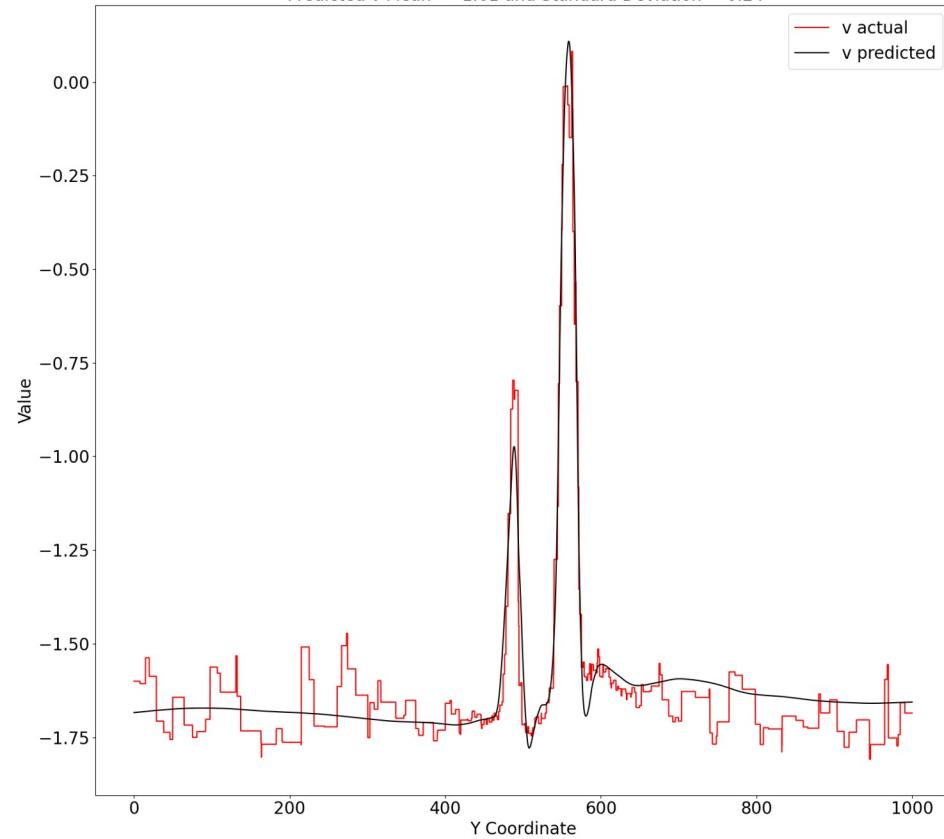


Comparison of Actual vs. Predicted values with Wind Angle = 60

Actual and Predicted v for Wind Angle = 60 with a cut at Z=50m and X=480m

Actual v Mean = -1.63 and Standard Deviation = 0.24

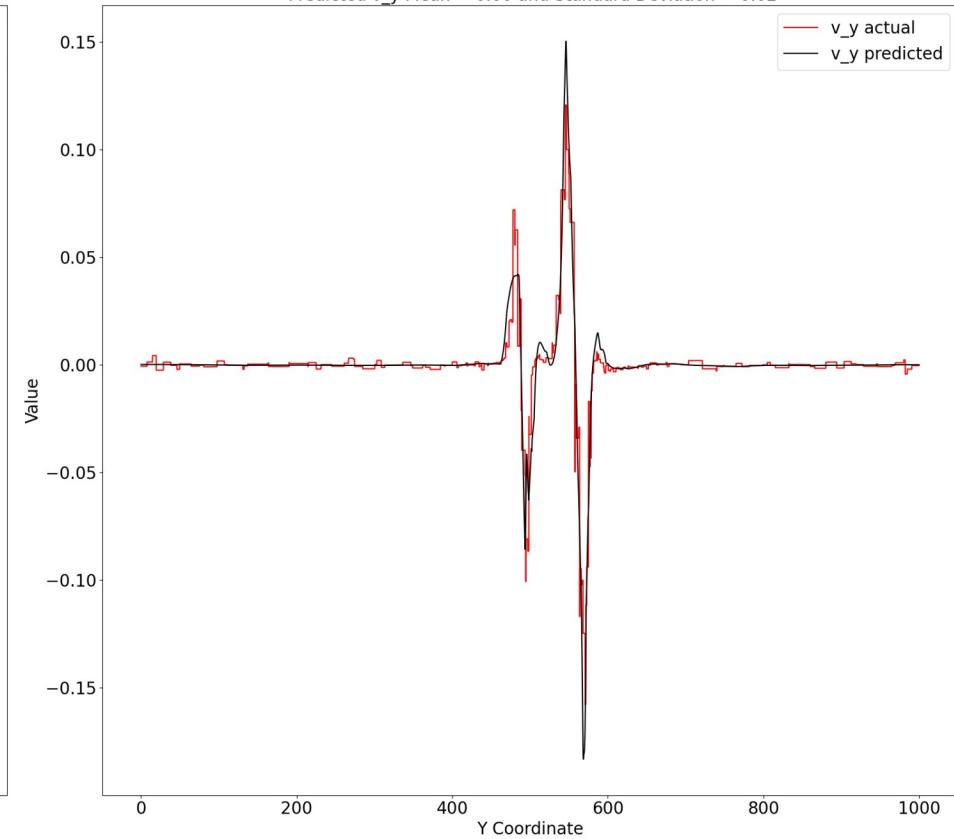
Predicted v Mean = -1.61 and Standard Deviation = 0.24



Actual and Predicted v_y for Wind Angle = 60 with a cut at Z=50m and X=480m

Actual v_y Mean = -0.00 and Standard Deviation = 0.02

Predicted v_y Mean = 0.00 and Standard Deviation = 0.02

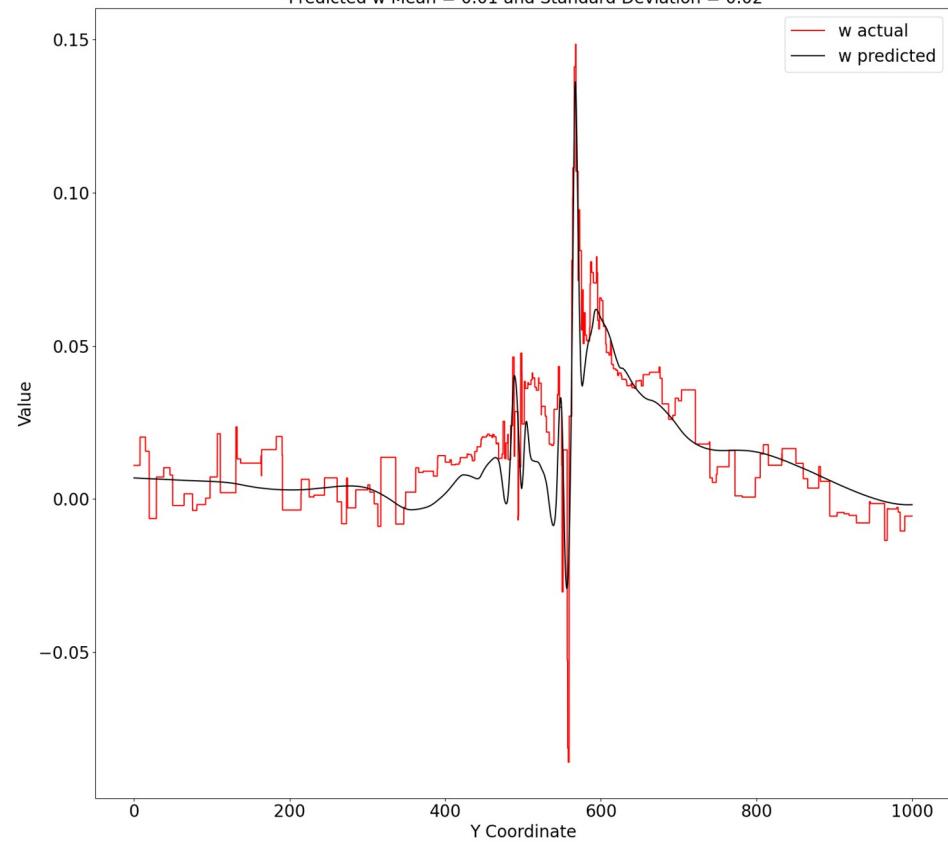


Comparison of Actual vs. Predicted values with Wind Angle = 60

Actual and Predicted w for Wind Angle = 60 with a cut at Z=50m and X=480m

Actual w Mean = 0.01 and Standard Deviation = 0.02

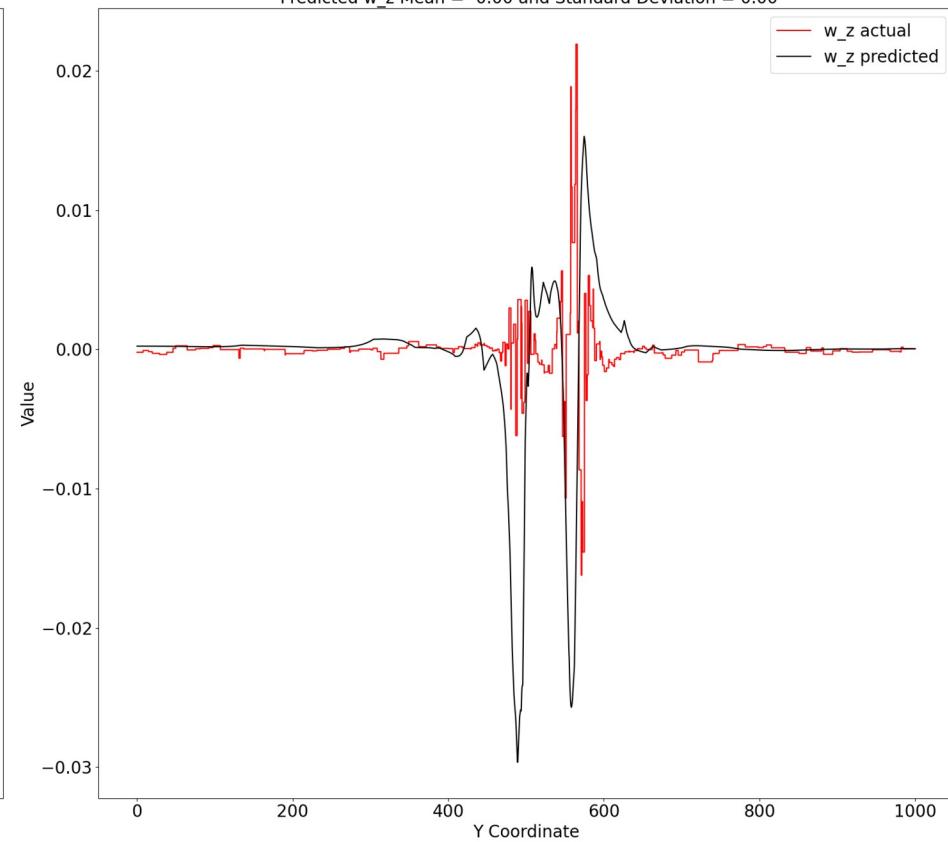
Predicted w Mean = 0.01 and Standard Deviation = 0.02



Actual and Predicted w_z for Wind Angle = 60 with a cut at Z=50m and X=480m

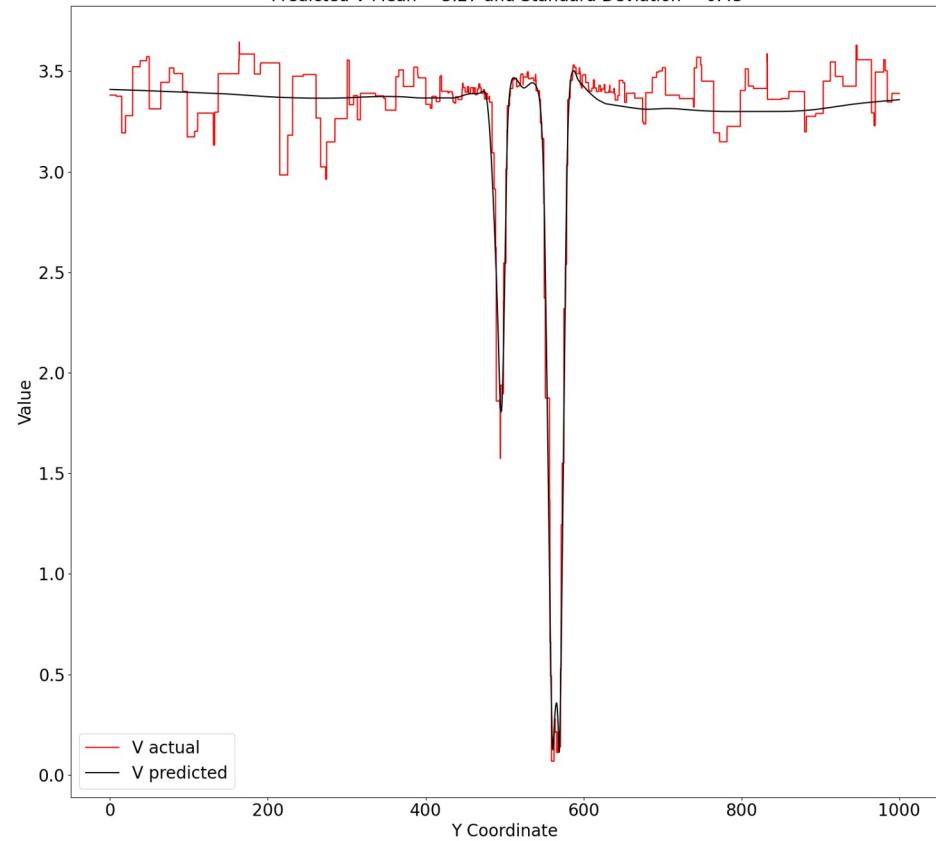
Actual w_z Mean = -0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

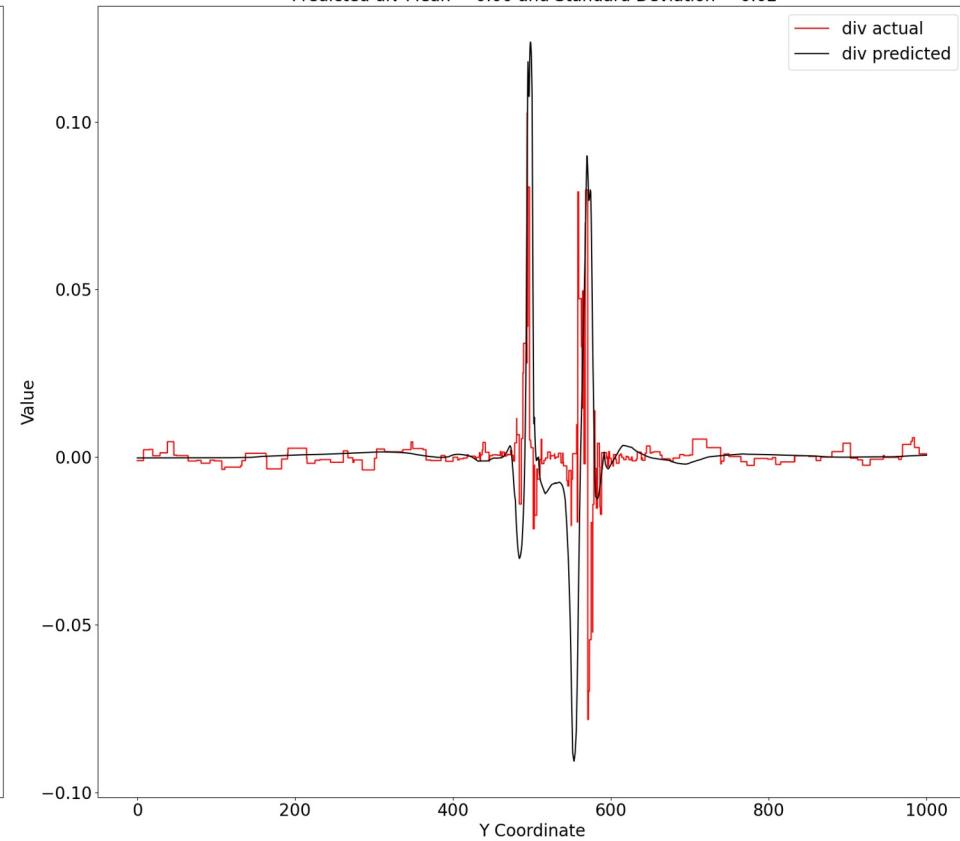


Comparison of Actual vs. Predicted values with Wind Angle = 75

Actual and Predicted V for Wind Angle = 75 with a cut at Z=50m and X=480m
Actual V Mean = 3.31 and Standard Deviation = 0.46
Predicted V Mean = 3.27 and Standard Deviation = 0.43

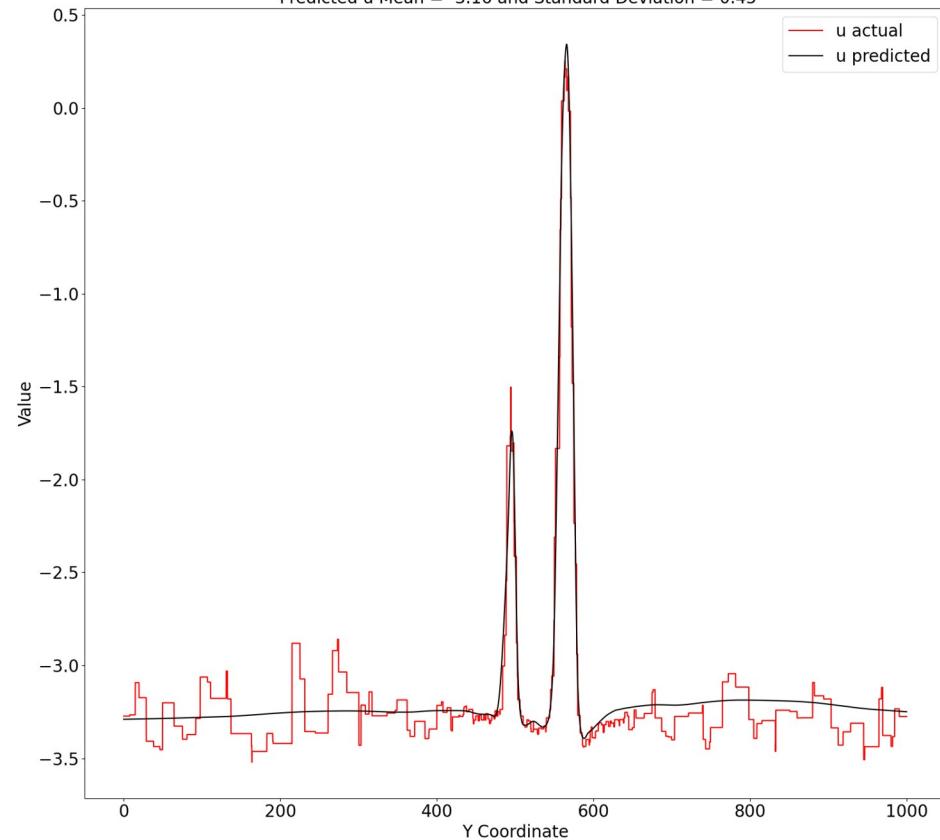


Actual and Predicted div for Wind Angle = 75 with a cut at Z=50m and X=480m
Actual div Mean = 0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.02

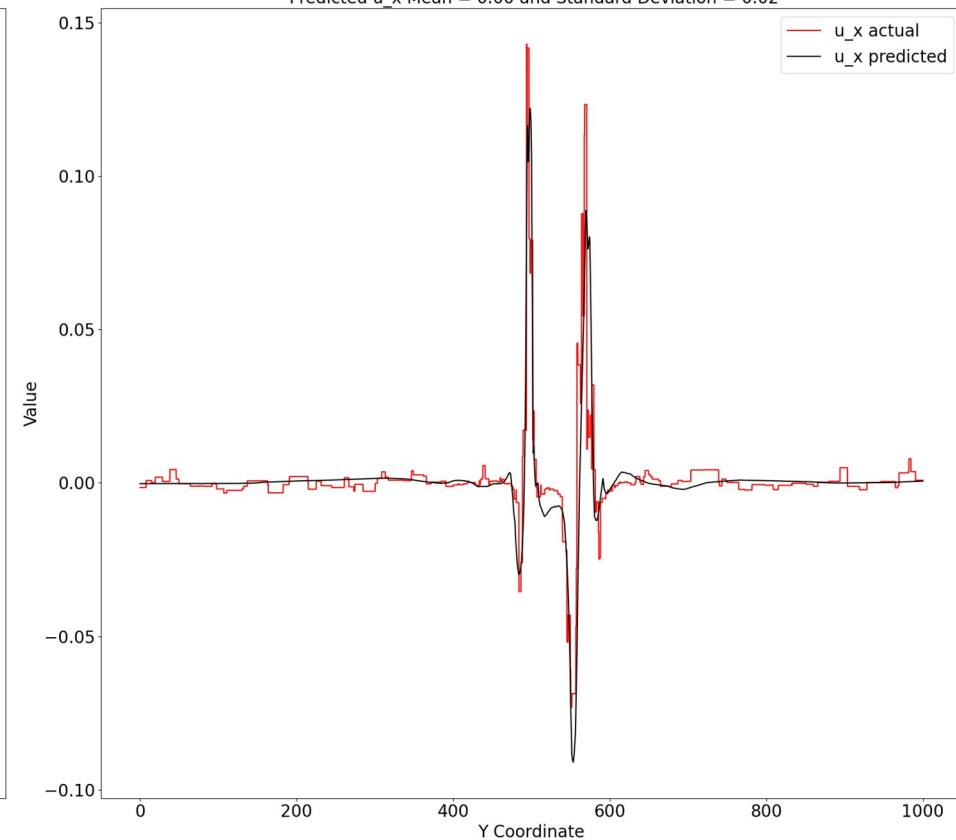


Comparison of Actual vs. Predicted values with Wind Angle = 75

Actual and Predicted u for Wind Angle = 75 with a cut at Z=50m and X=480m
 Actual u Mean = -3.19 and Standard Deviation = 0.46
 Predicted u Mean = -3.16 and Standard Deviation = 0.45

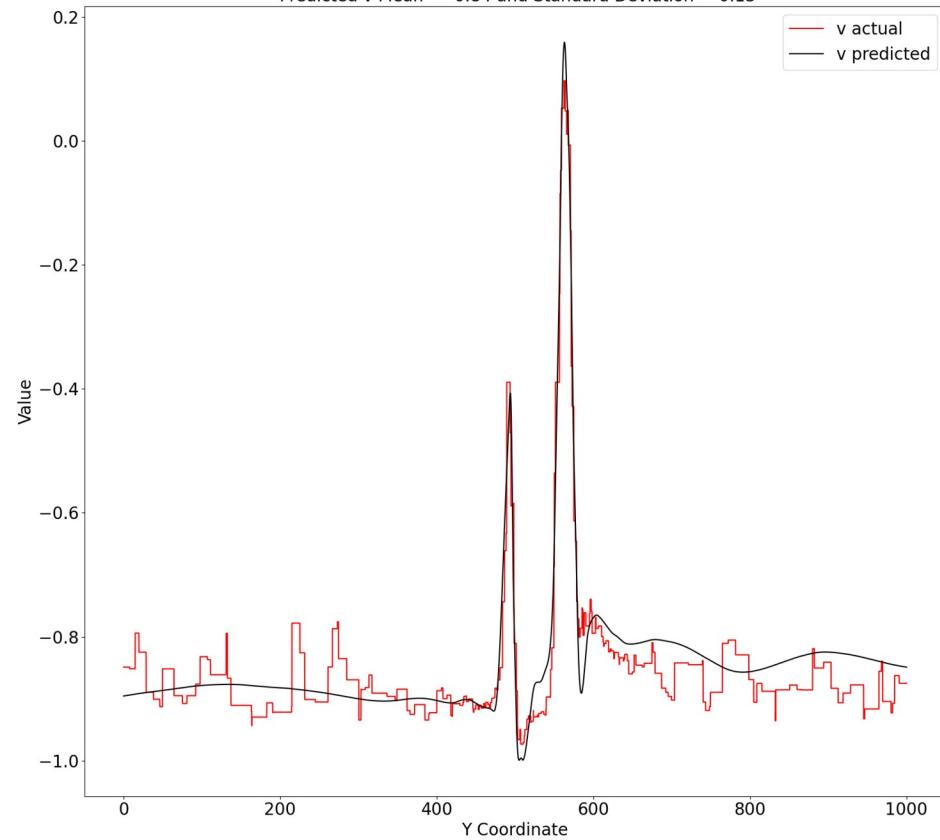


Actual and Predicted u_x for Wind Angle = 75 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.02
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

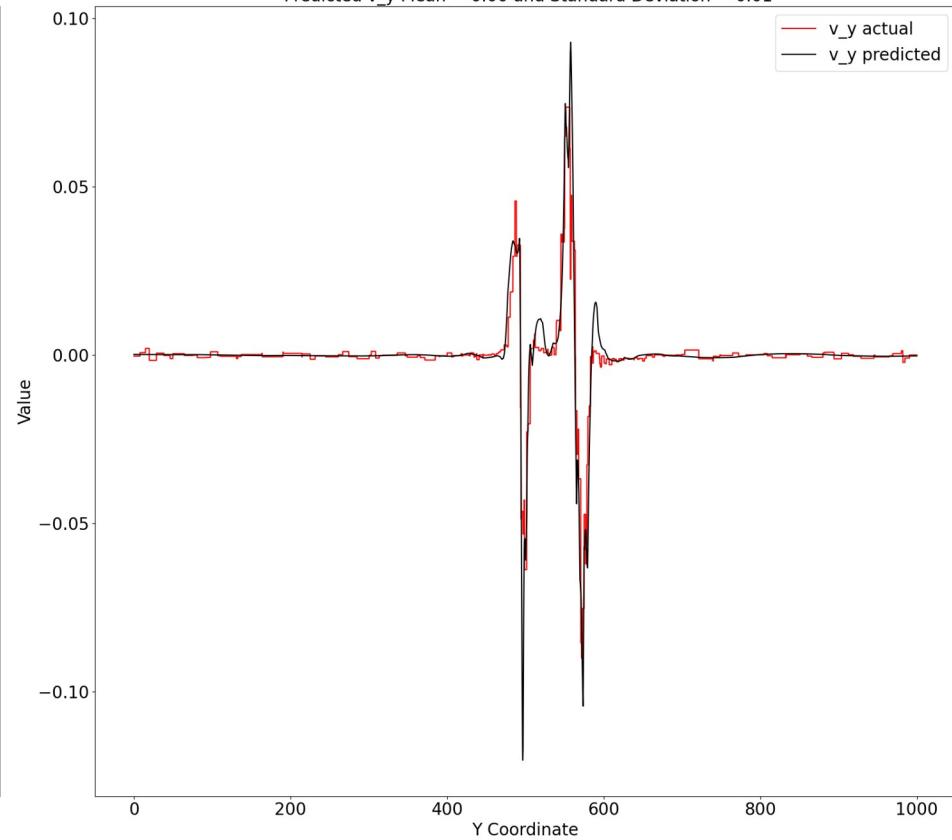


Comparison of Actual vs. Predicted values with Wind Angle = 75

Actual and Predicted v for Wind Angle = 75 with a cut at Z=50m and X=480m
 Actual v Mean = -0.85 and Standard Deviation = 0.13
 Predicted v Mean = -0.84 and Standard Deviation = 0.13

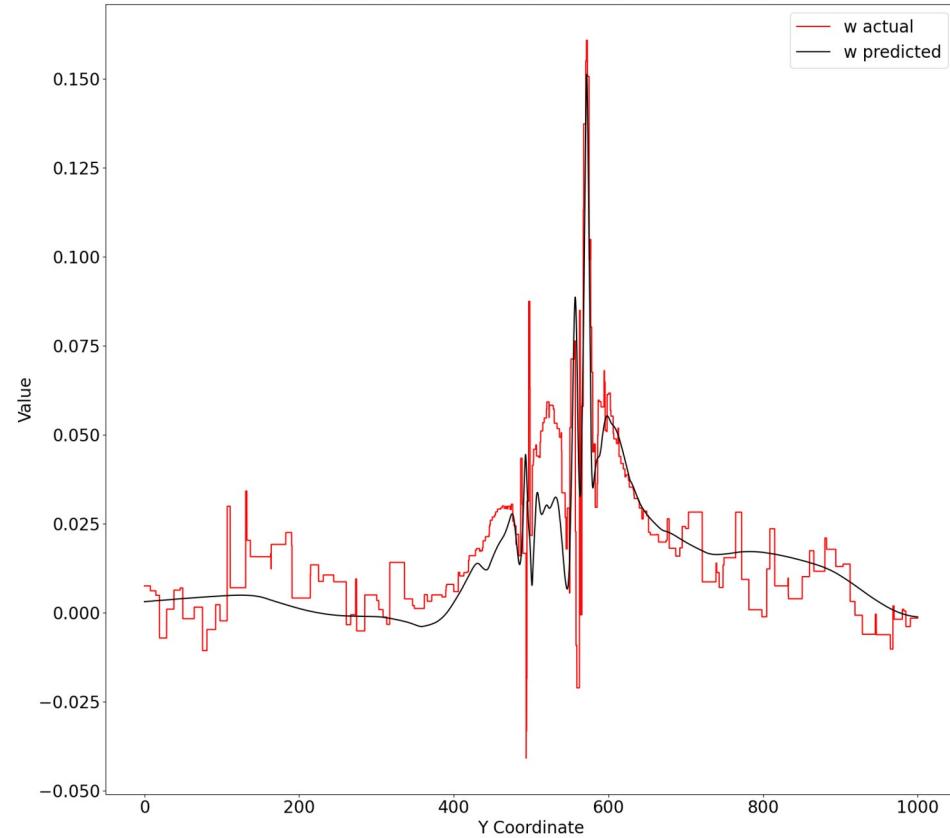


Actual and Predicted v_y for Wind Angle = 75 with a cut at Z=50m and X=480m
 Actual v_y Mean = -0.00 and Standard Deviation = 0.01
 Predicted v_y Mean = 0.00 and Standard Deviation = 0.01

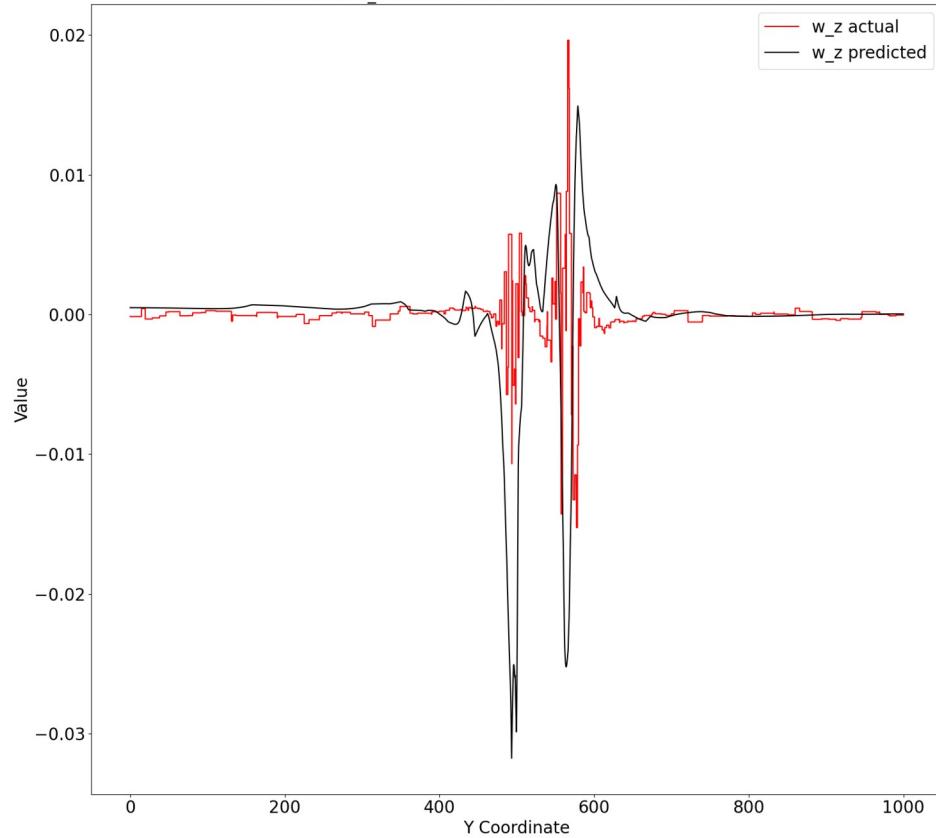


Comparison of Actual vs. Predicted values with Wind Angle = 75

Actual and Predicted w for Wind Angle = 75 with a cut at Z=50m and X=480m
Actual w Mean = 0.02 and Standard Deviation = 0.02
Predicted w Mean = 0.01 and Standard Deviation = 0.02

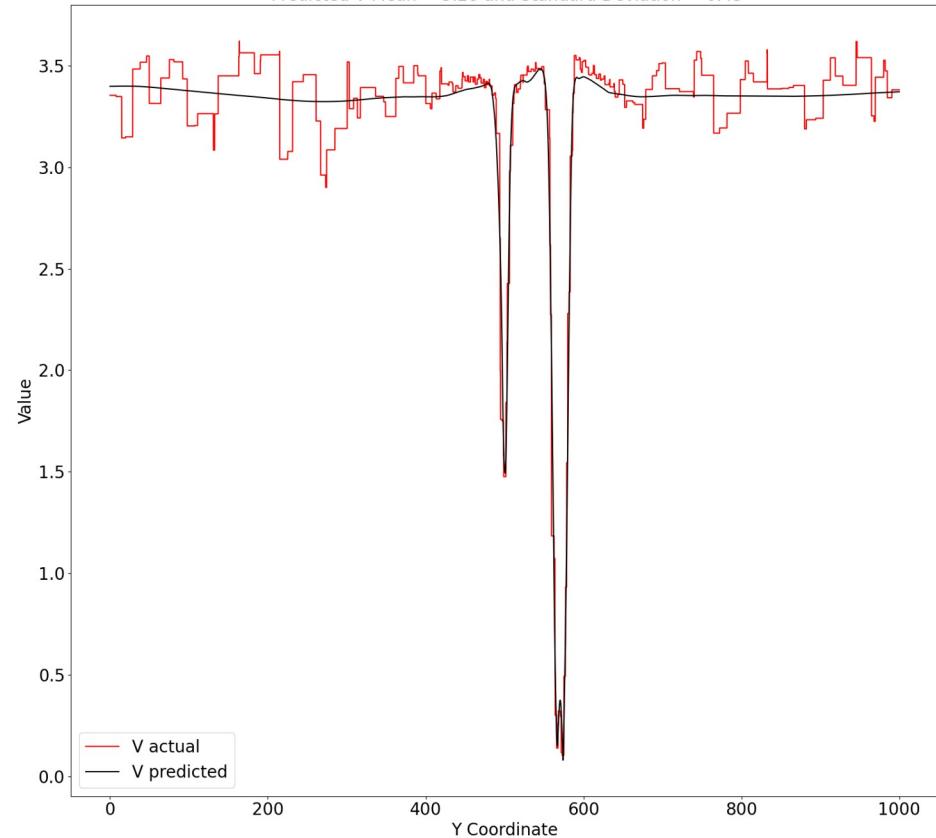


Actual and Predicted w_z for Wind Angle = 75 with a cut at Z=50m and X=480m
Actual w_z Mean = -0.00 and Standard Deviation = 0.00
Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

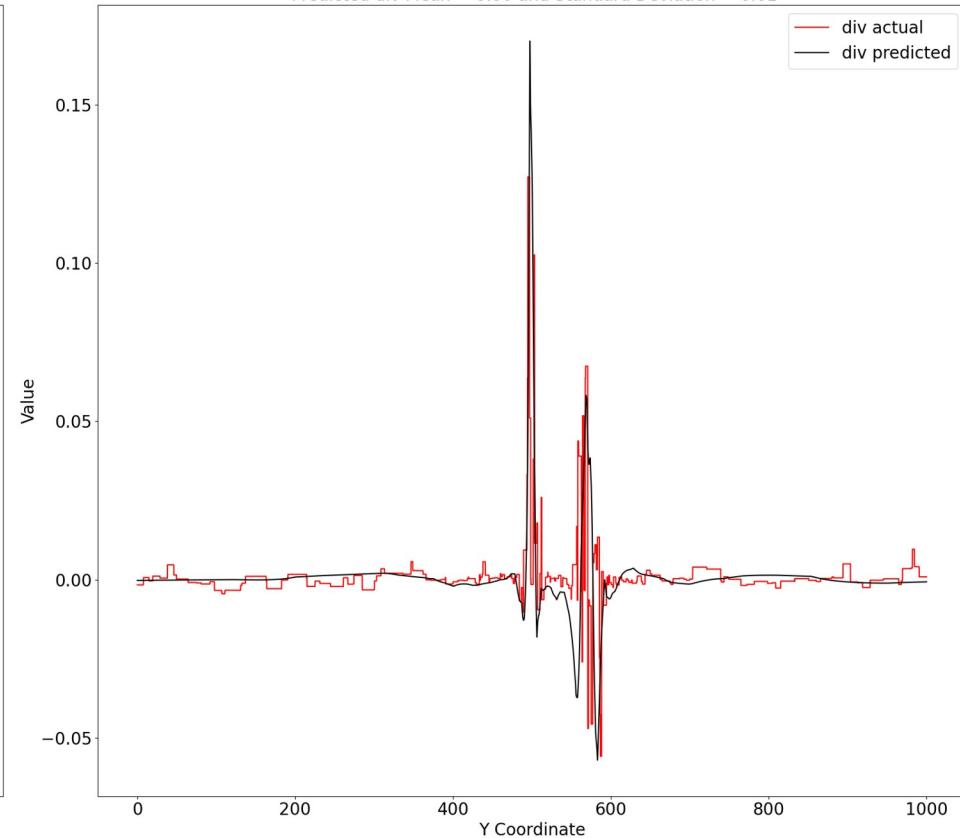


Comparison of Actual vs. Predicted values with Wind Angle = 90

Actual and Predicted V for Wind Angle = 90 with a cut at Z=50m and X=480m
Actual V Mean = 3.30 and Standard Deviation = 0.45
Predicted V Mean = 3.28 and Standard Deviation = 0.43

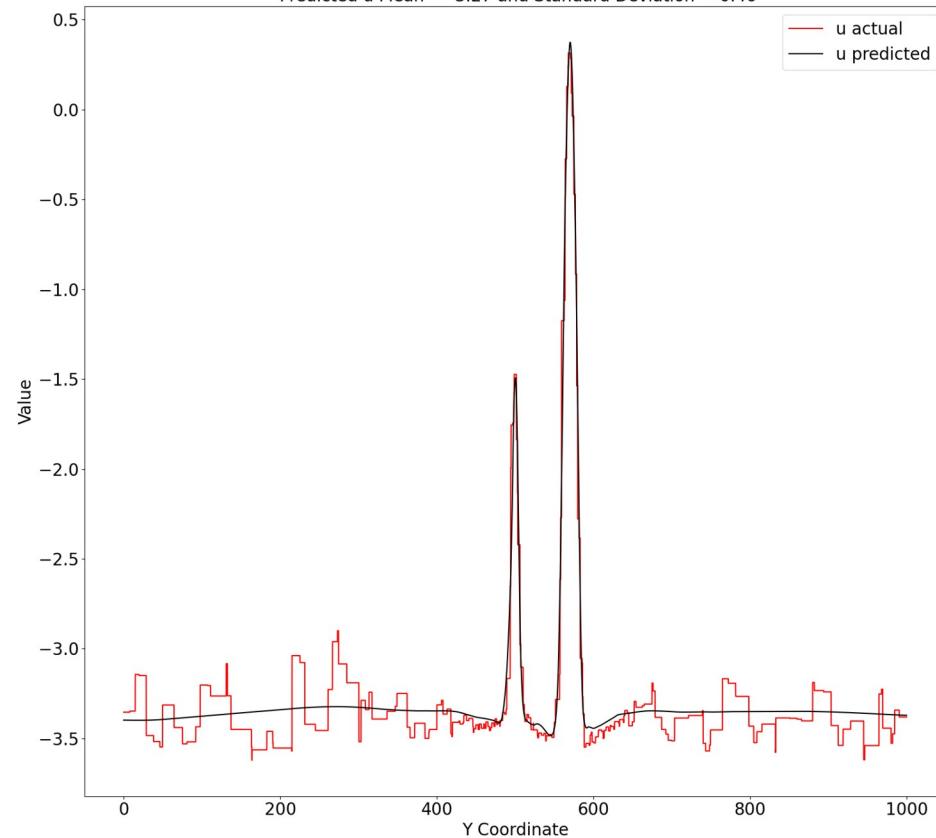


Actual and Predicted div for Wind Angle = 90 with a cut at Z=50m and X=480m
Actual div Mean = 0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.01

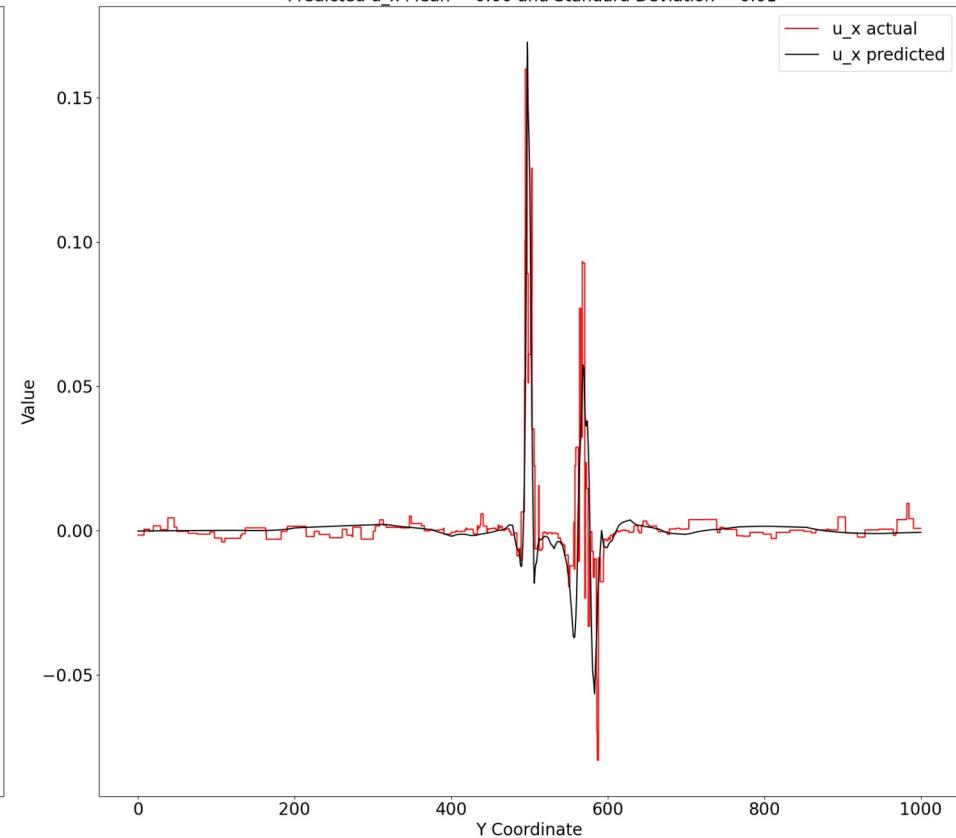


Comparison of Actual vs. Predicted values with Wind Angle = 90

Actual and Predicted u for Wind Angle = 90 with a cut at Z=50m and X=480m
 Actual u Mean = -3.29 and Standard Deviation = 0.48
 Predicted u Mean = -3.27 and Standard Deviation = 0.46



Actual and Predicted u_x for Wind Angle = 90 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.01
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.01

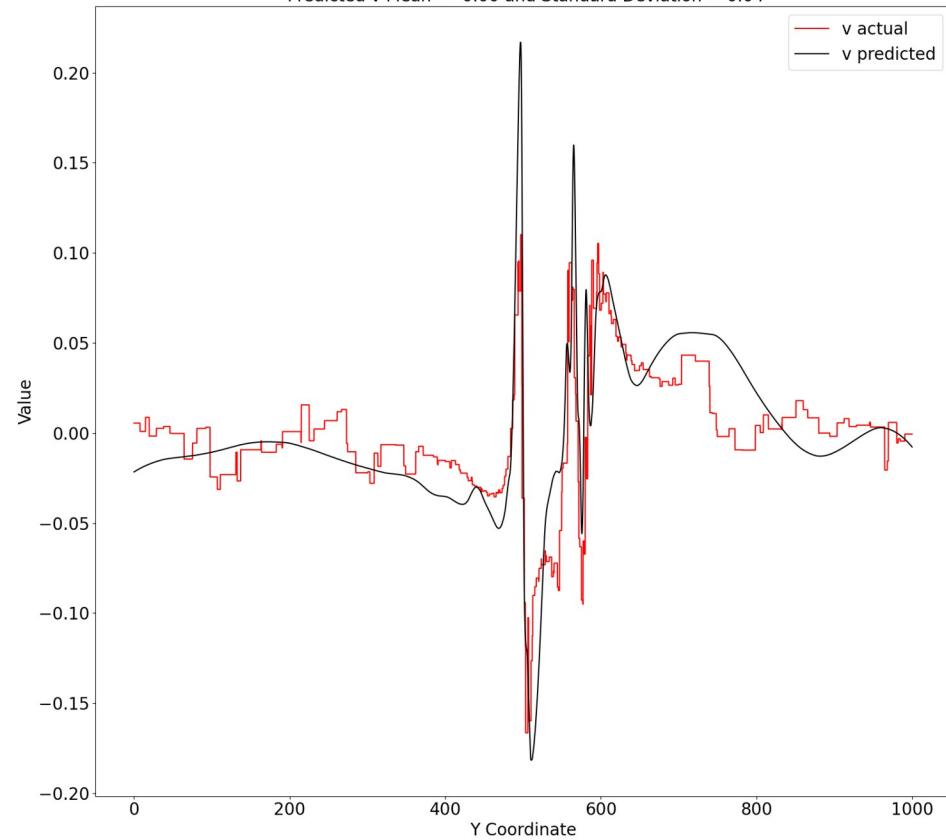


Comparison of Actual vs. Predicted values with Wind Angle = 90

Actual and Predicted v for Wind Angle = 90 with a cut at Z=50m and X=480m

Actual v Mean = -0.00 and Standard Deviation = 0.03

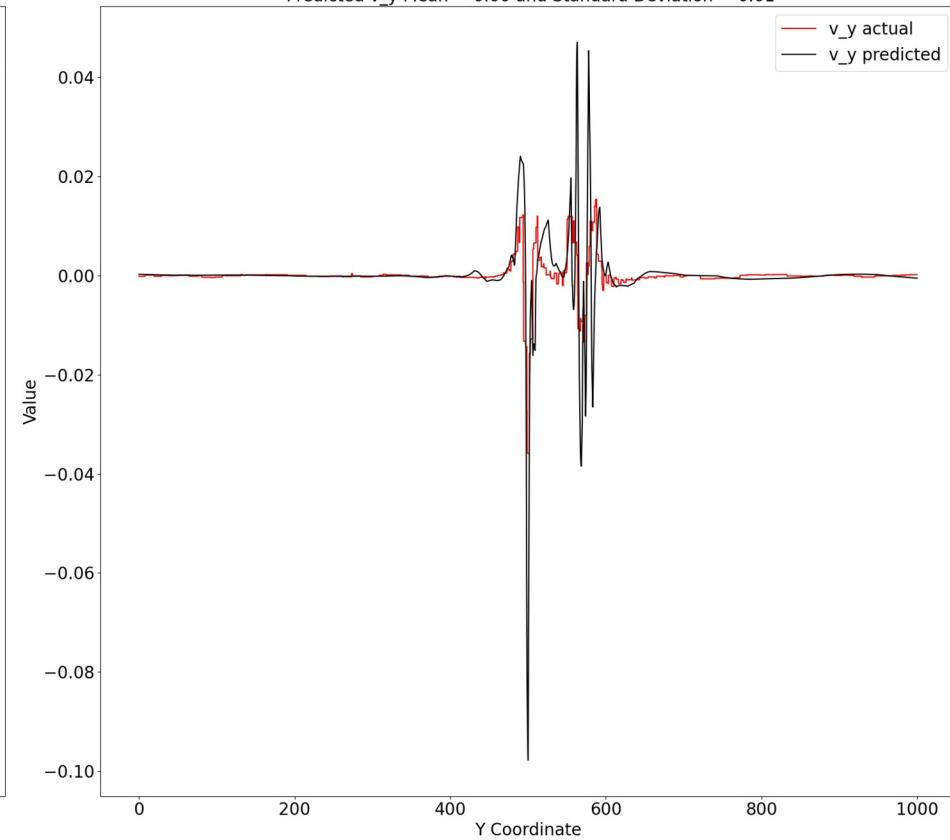
Predicted v Mean = -0.00 and Standard Deviation = 0.04



Actual and Predicted v_y for Wind Angle = 90 with a cut at Z=50m and X=480m

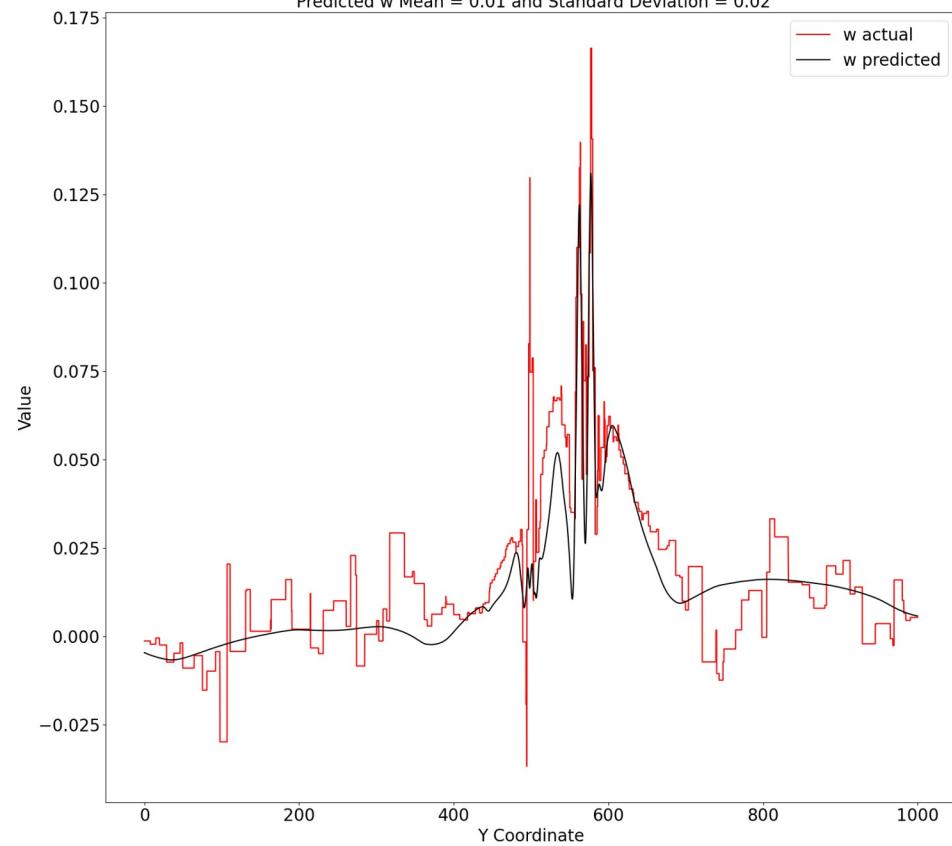
Actual v_y Mean = 0.00 and Standard Deviation = 0.00

Predicted v_y Mean = 0.00 and Standard Deviation = 0.01

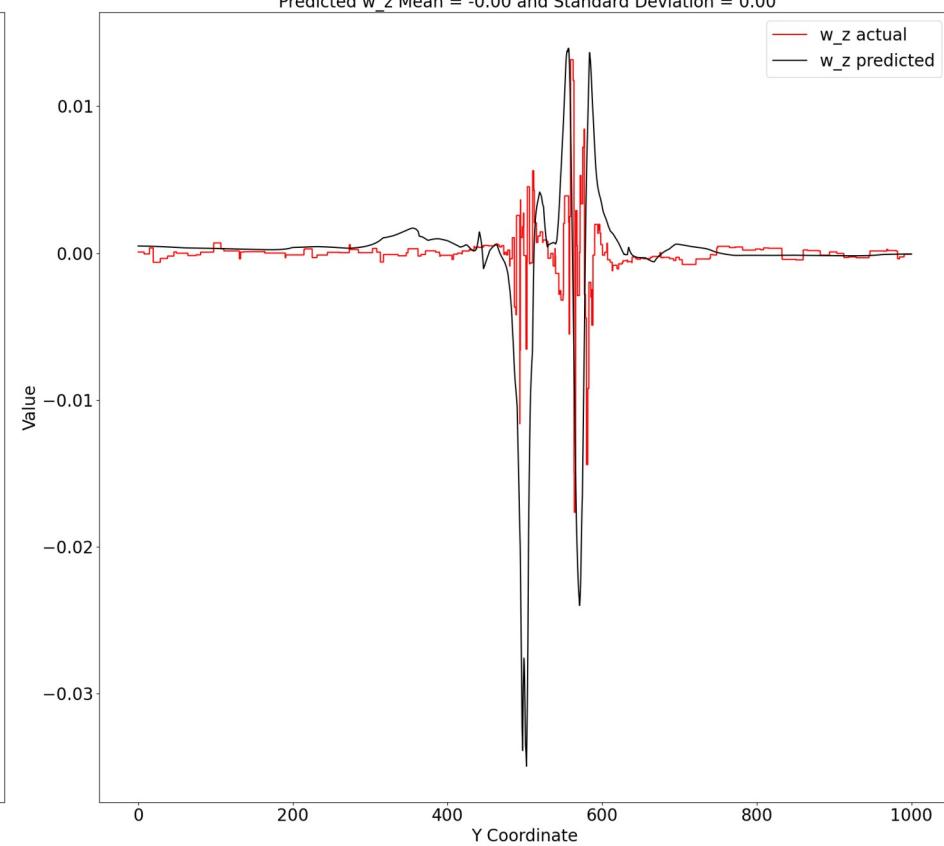


Comparison of Actual vs. Predicted values with Wind Angle = 90

Actual and Predicted w for Wind Angle = 90 with a cut at Z=50m and X=480m
Actual w Mean = 0.02 and Standard Deviation = 0.02
Predicted w Mean = 0.01 and Standard Deviation = 0.02

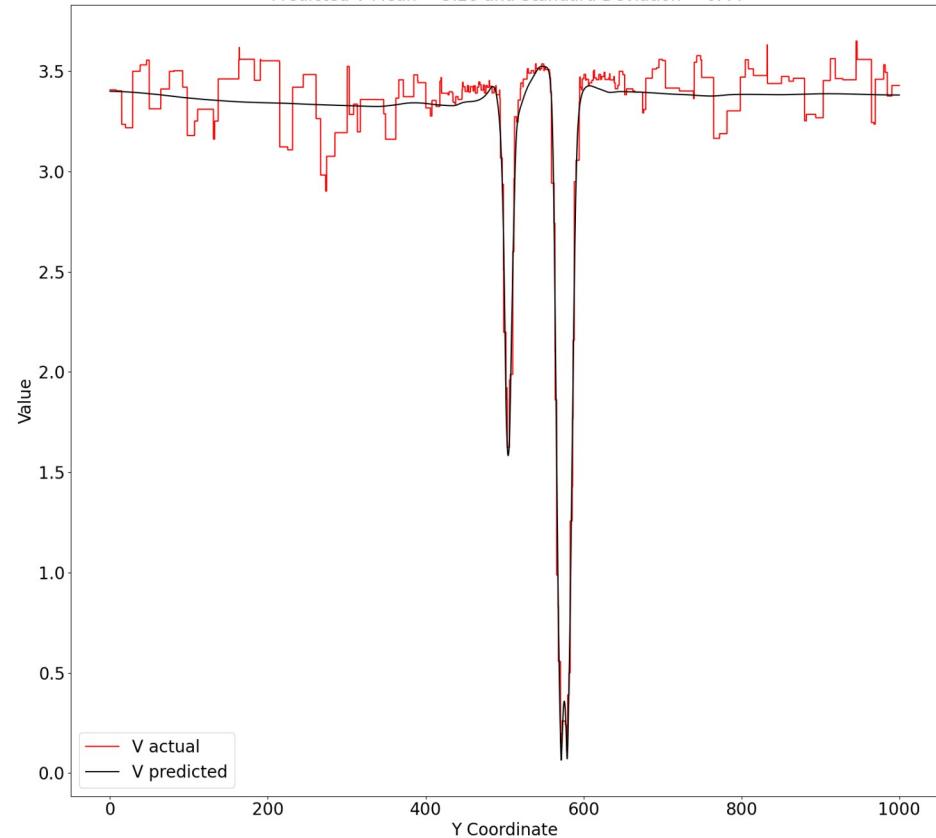


Actual and Predicted w_z for Wind Angle = 90 with a cut at Z=50m and X=480m
Actual w_z Mean = 0.00 and Standard Deviation = 0.00
Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

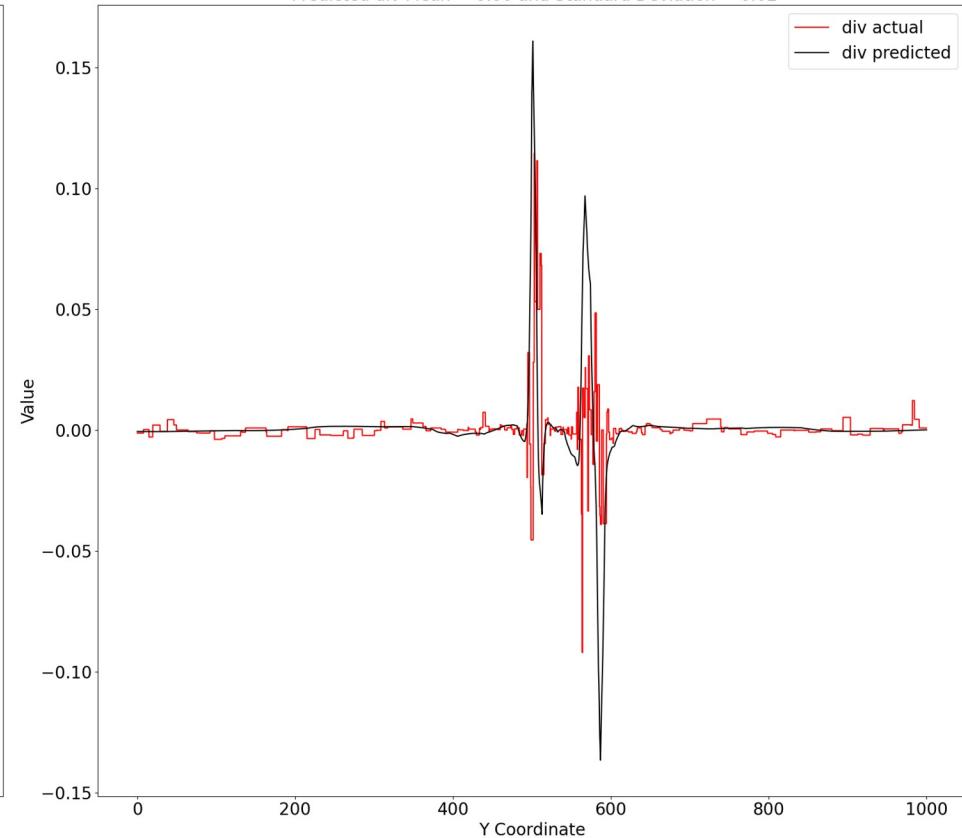


Comparison of Actual vs. Predicted values with Wind Angle = 105

Actual and Predicted V for Wind Angle = 105 with a cut at Z=50m and X=480m
 Actual V Mean = 3.31 and Standard Deviation = 0.46
 Predicted V Mean = 3.28 and Standard Deviation = 0.44

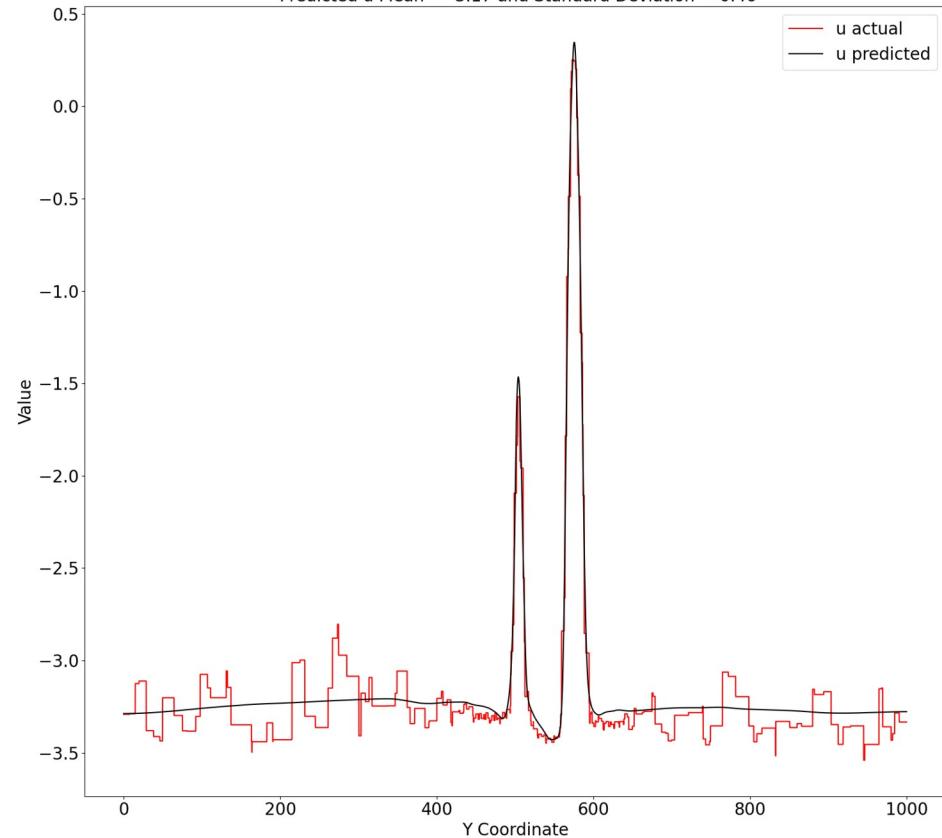


Actual and Predicted div for Wind Angle = 105 with a cut at Z=50m and X=480m
 Actual div Mean = 0.00 and Standard Deviation = 0.01
 Predicted div Mean = 0.00 and Standard Deviation = 0.02

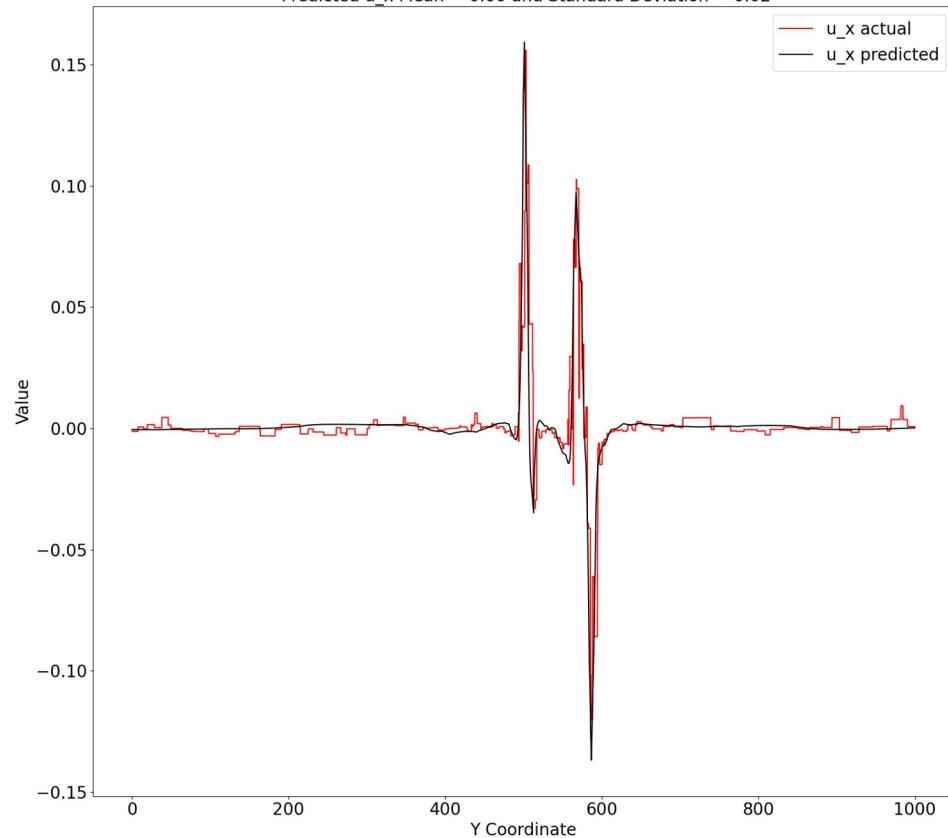


Comparison of Actual vs. Predicted values with Wind Angle = 105

Actual and Predicted u for Wind Angle = 105 with a cut at Z=50m and X=480m
 Actual u Mean = -3.20 and Standard Deviation = 0.47
 Predicted u Mean = -3.17 and Standard Deviation = 0.46

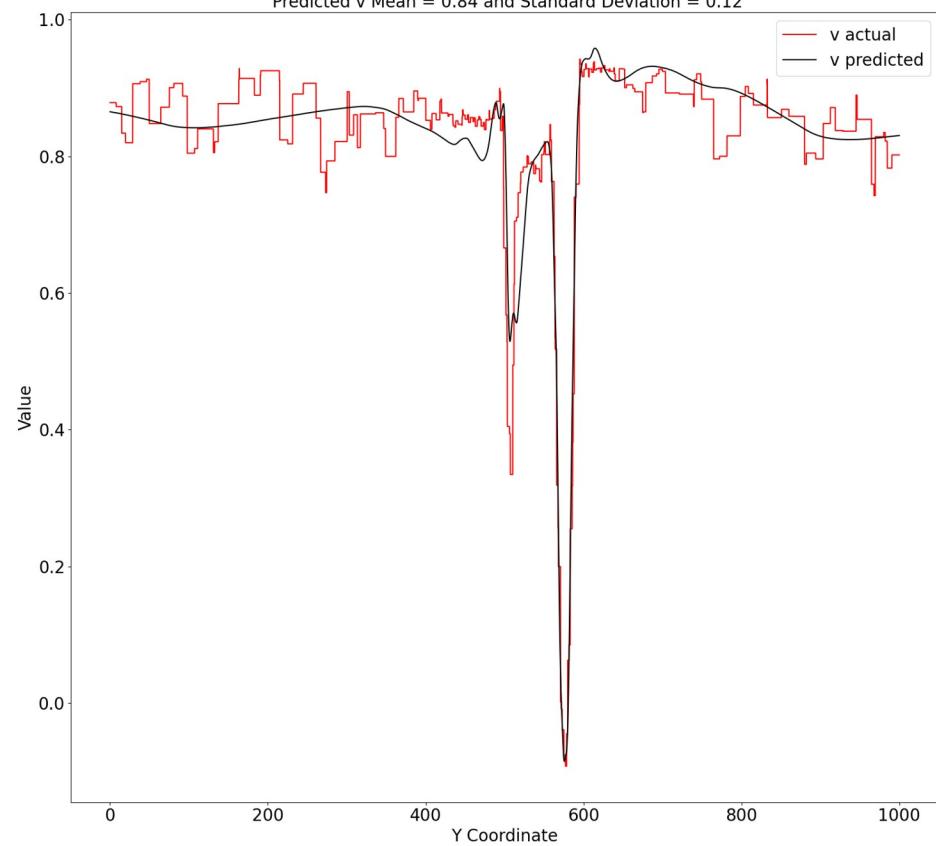


Actual and Predicted u_x for Wind Angle = 105 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.02
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

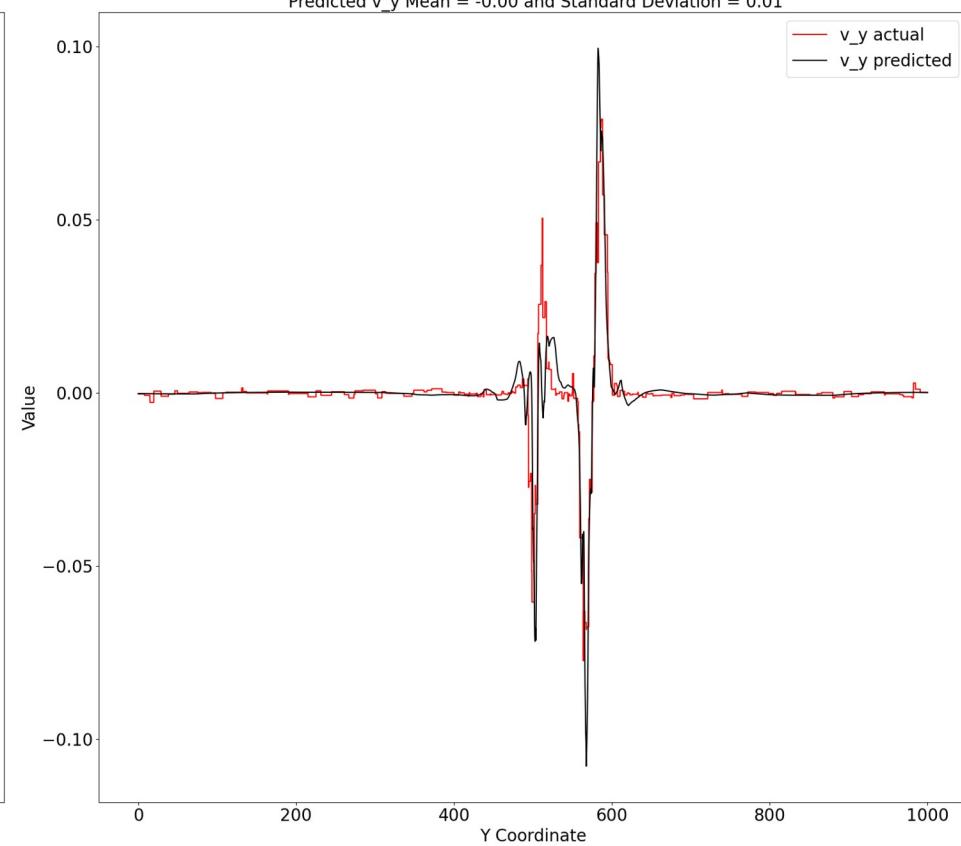


Comparison of Actual vs. Predicted values with Wind Angle = 105

Actual and Predicted v for Wind Angle = 105 with a cut at Z=50m and X=480m
Actual v Mean = 0.84 and Standard Deviation = 0.13
Predicted v Mean = 0.84 and Standard Deviation = 0.12

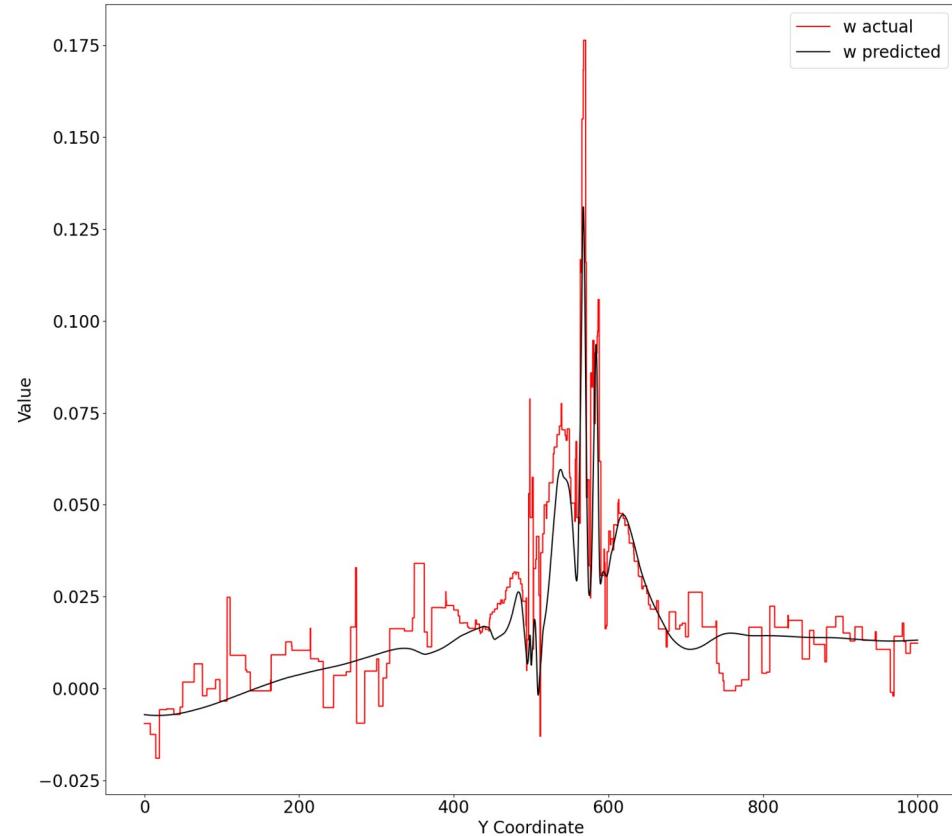


Actual and Predicted v_y for Wind Angle = 105 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.01
Predicted v_y Mean = -0.00 and Standard Deviation = 0.01

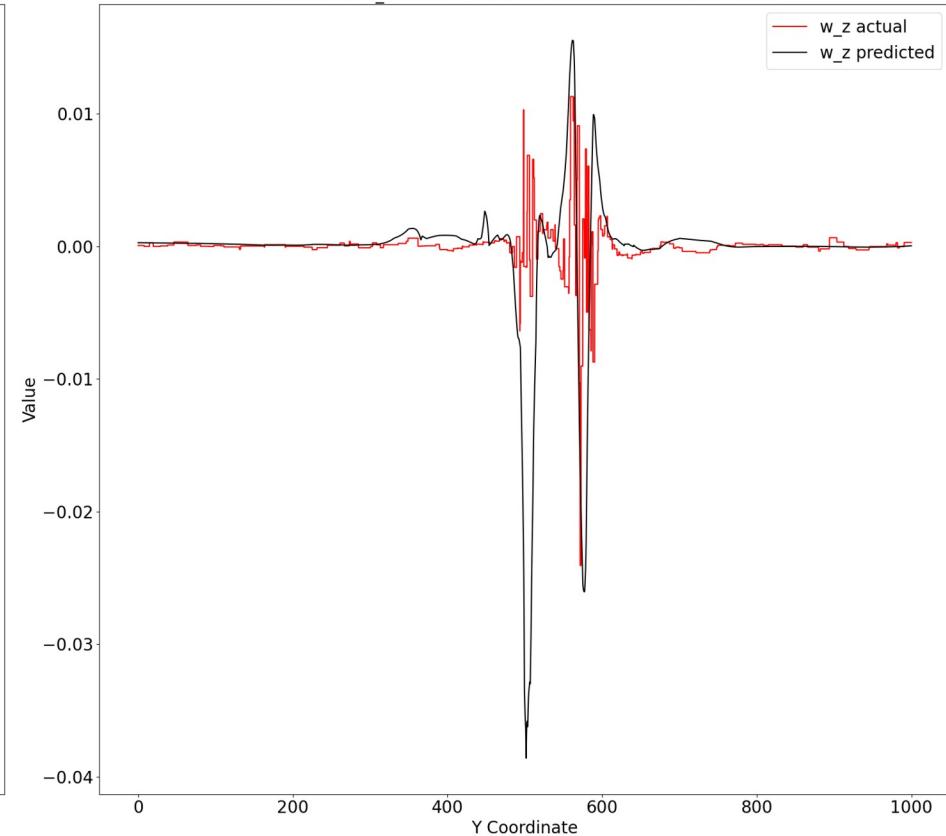


Comparison of Actual vs. Predicted values with Wind Angle = 105

Actual and Predicted w for Wind Angle = 105 with a cut at Z=50m and X=480m
Actual w Mean = 0.02 and Standard Deviation = 0.02
Predicted w Mean = 0.01 and Standard Deviation = 0.02

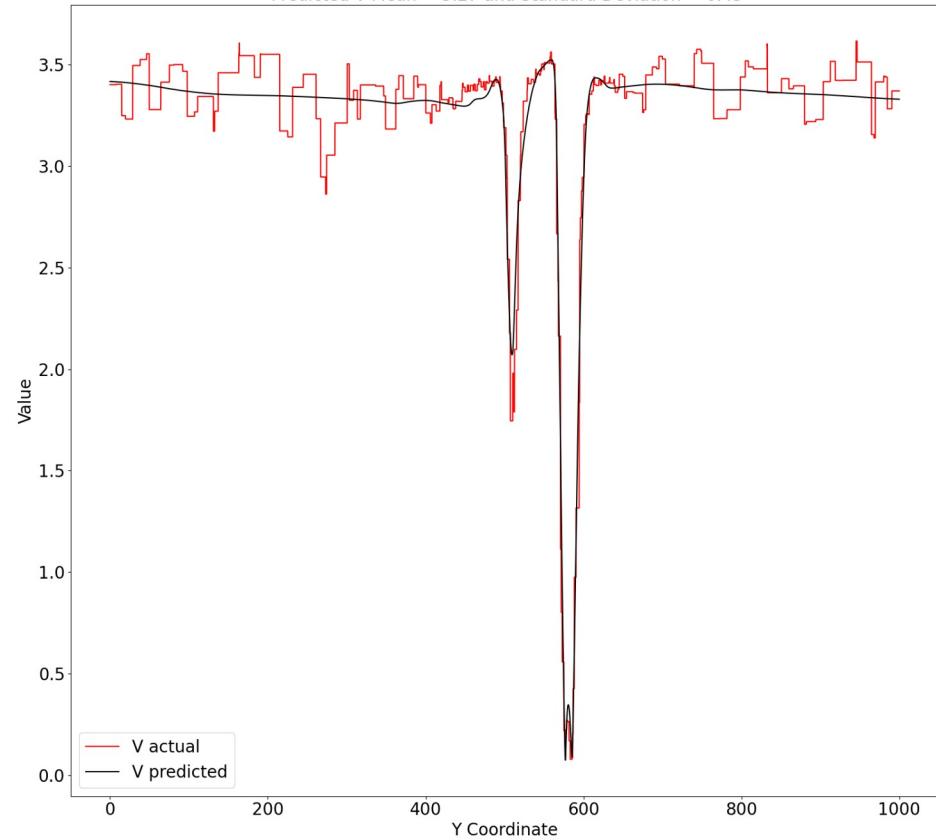


Actual and Predicted w_z for Wind Angle = 105 with a cut at Z=50m and X=480m
Actual w_z Mean = 0.00 and Standard Deviation = 0.00
Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

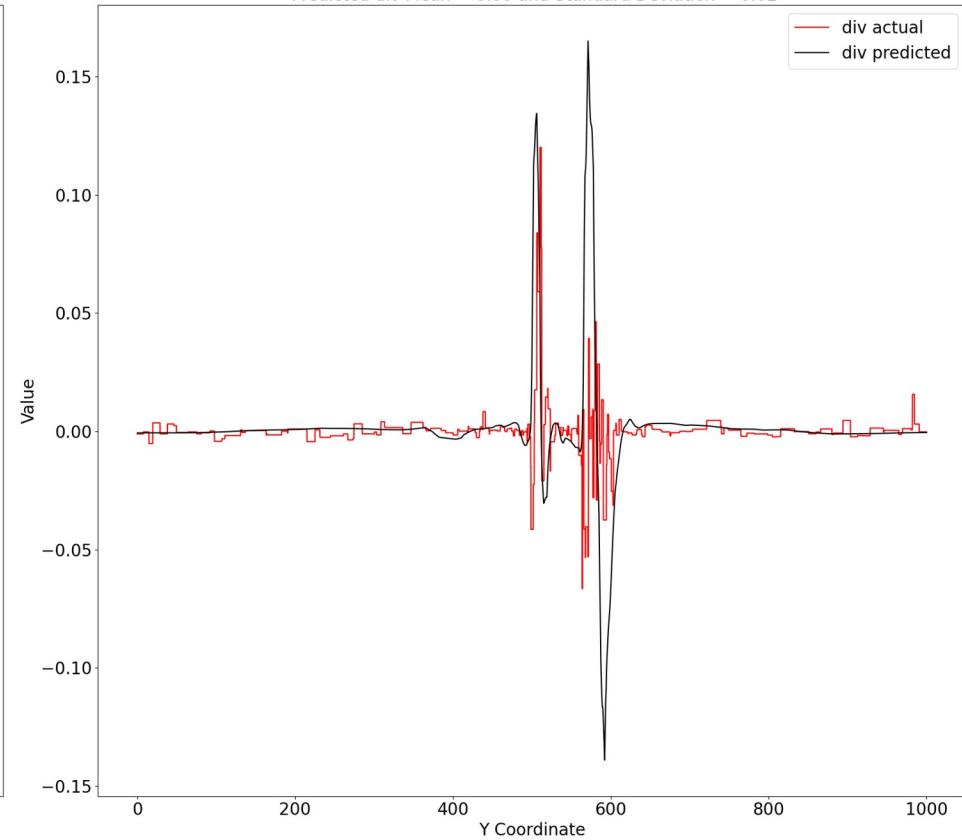


Comparison of Actual vs. Predicted values with Wind Angle = 120

Actual and Predicted V for Wind Angle = 120 with a cut at Z=50m and X=480m
Actual V Mean = 3.28 and Standard Deviation = 0.48
Predicted V Mean = 3.27 and Standard Deviation = 0.45

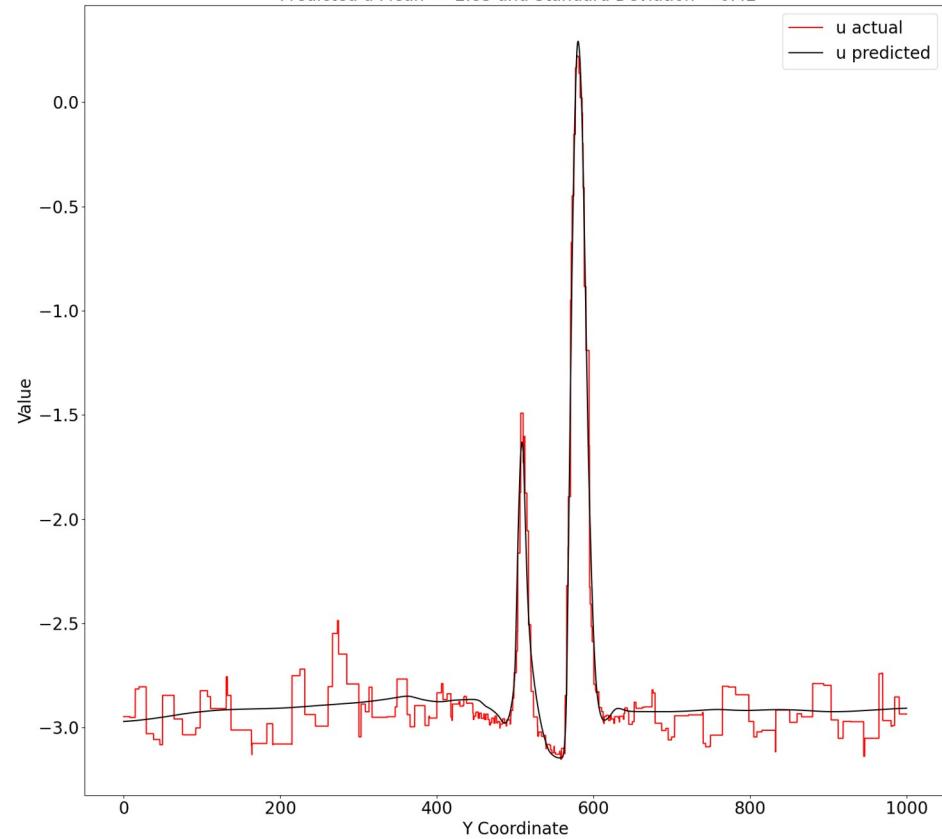


Actual and Predicted div for Wind Angle = 120 with a cut at Z=50m and X=480m
Actual div Mean = 0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.02

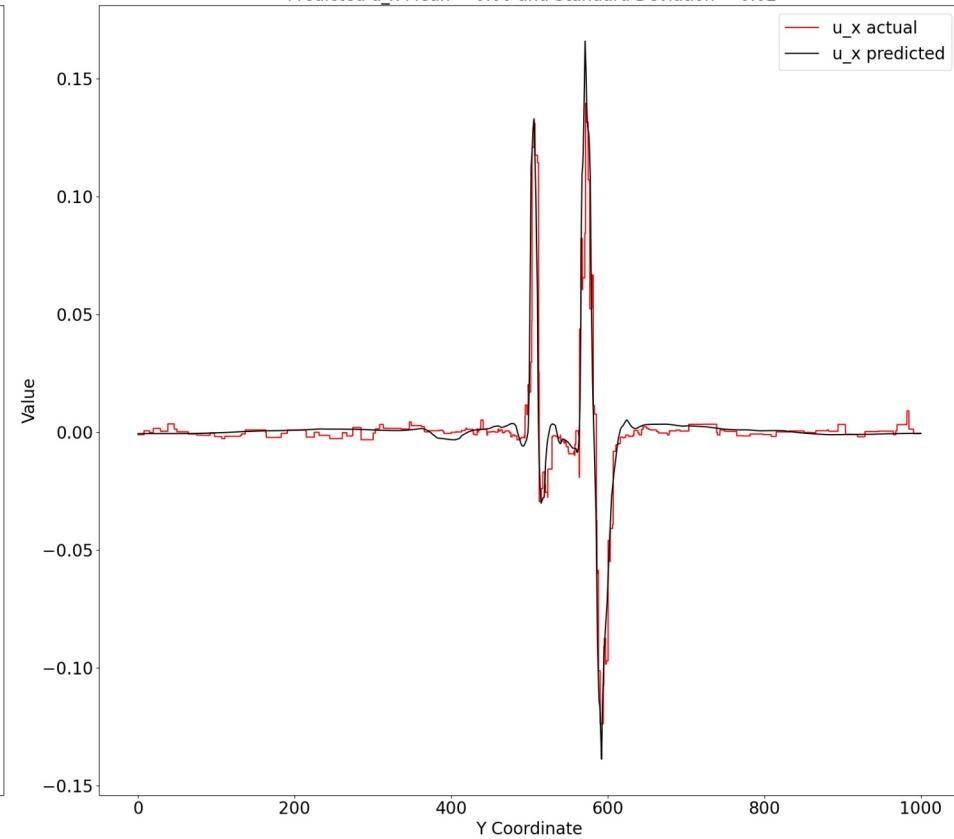


Comparison of Actual vs. Predicted values with Wind Angle = 120

Actual and Predicted u for Wind Angle = 120 with a cut at Z=50m and X=480m
 Actual u Mean = -2.85 and Standard Deviation = 0.43
 Predicted u Mean = -2.83 and Standard Deviation = 0.42

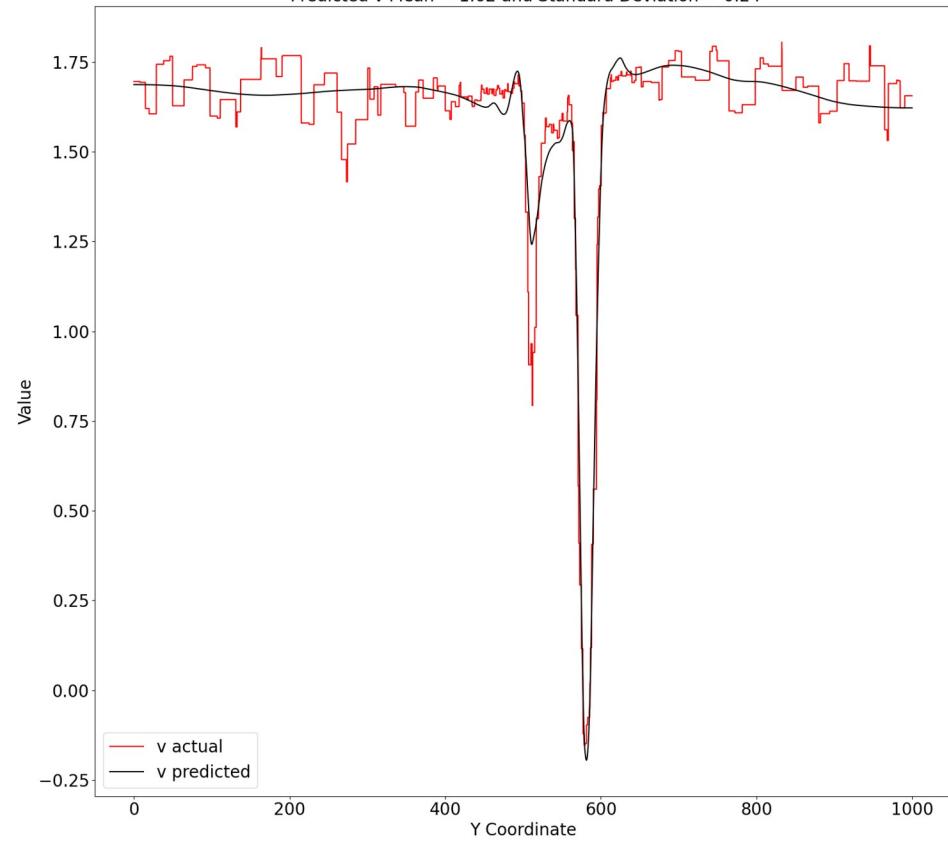


Actual and Predicted u_x for Wind Angle = 120 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.02
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

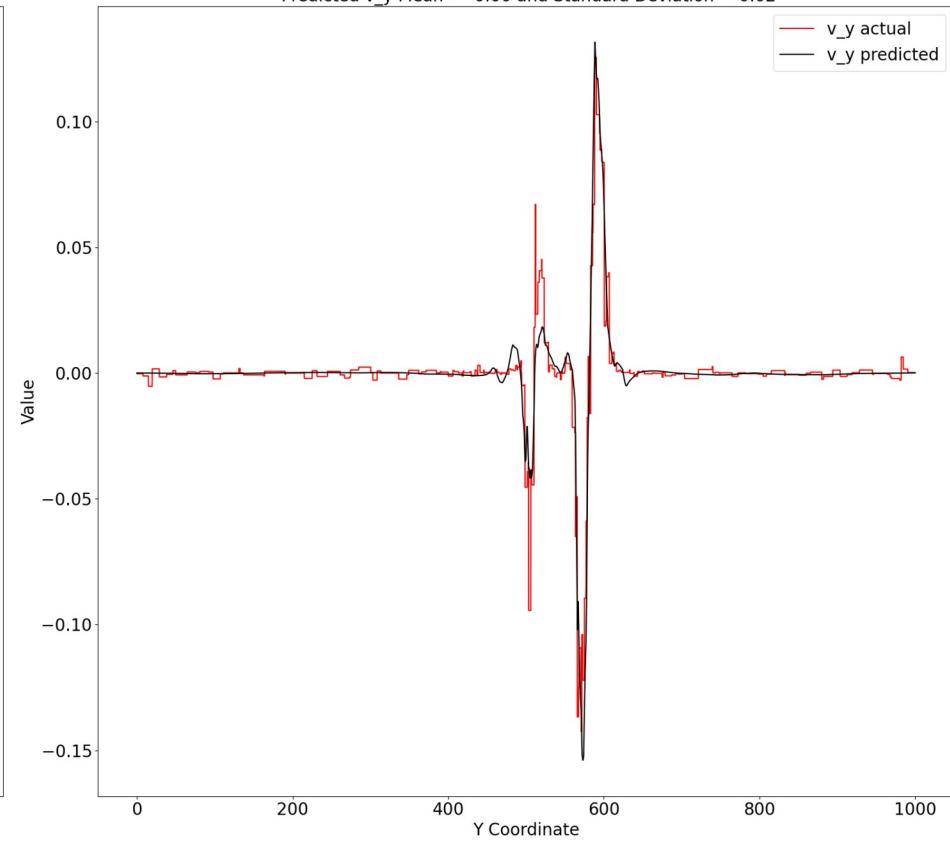


Comparison of Actual vs. Predicted values with Wind Angle = 120

Actual and Predicted v for Wind Angle = 120 with a cut at Z=50m and X=480m
Actual v Mean = 1.62 and Standard Deviation = 0.25
Predicted v Mean = 1.62 and Standard Deviation = 0.24



Actual and Predicted v_y for Wind Angle = 120 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.02
Predicted v_y Mean = -0.00 and Standard Deviation = 0.02

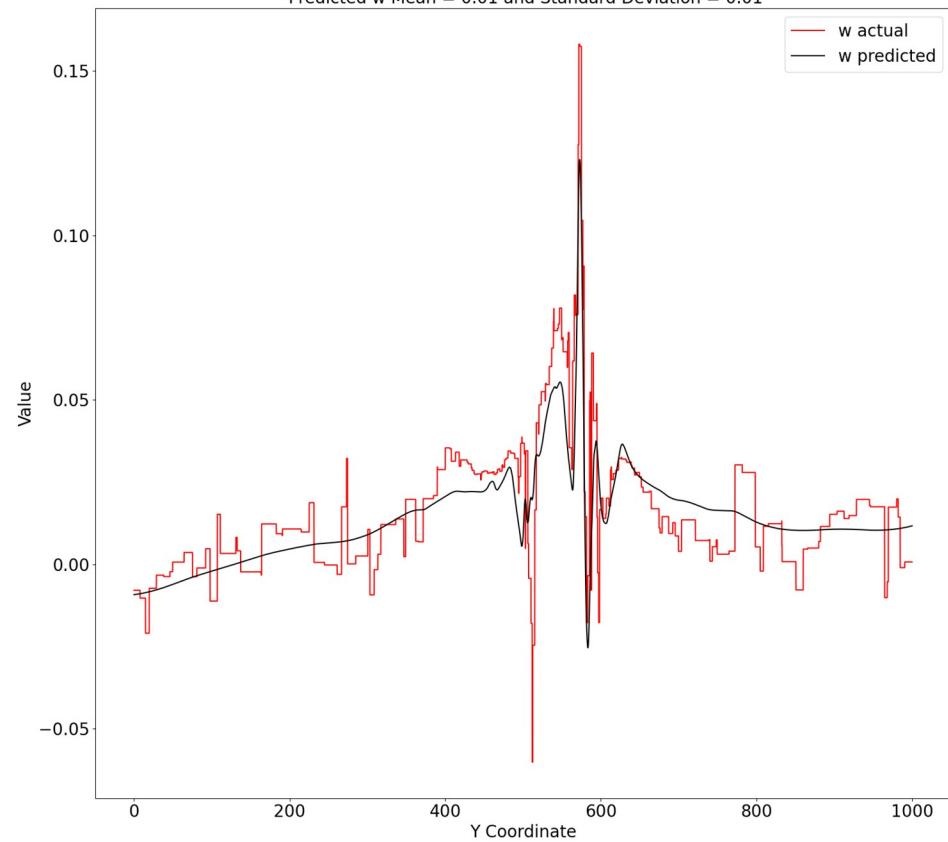


Comparison of Actual vs. Predicted values with Wind Angle = 120

Actual and Predicted w for Wind Angle = 120 with a cut at Z=50m and X=480m

Actual w Mean = 0.02 and Standard Deviation = 0.02

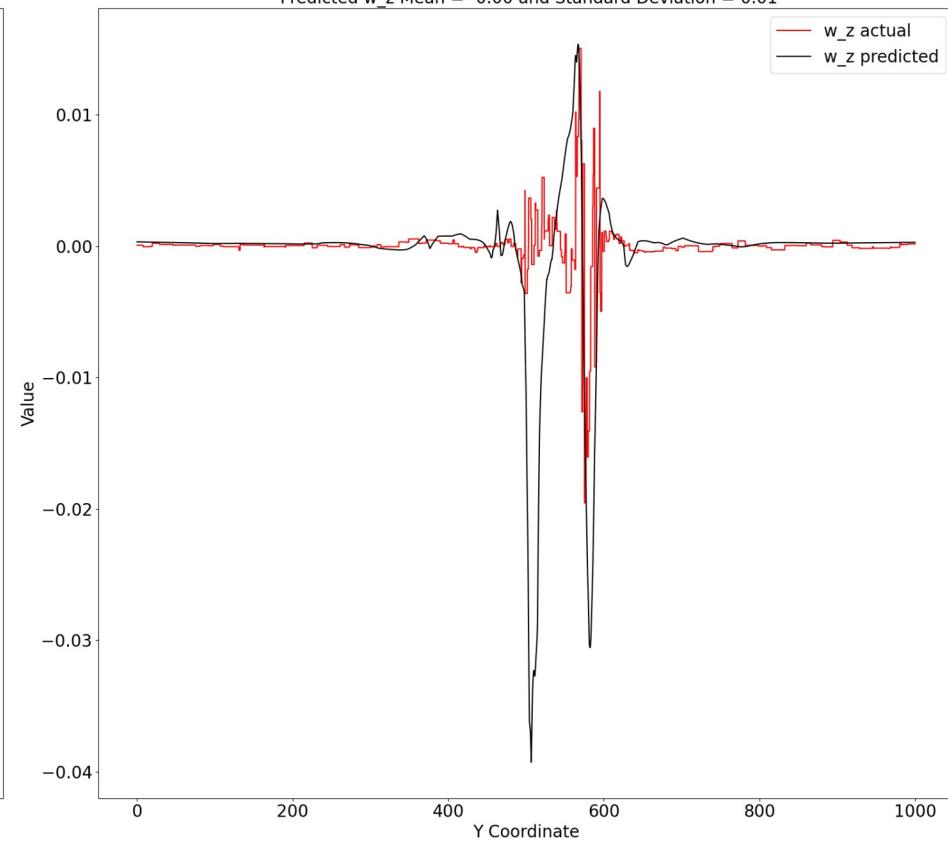
Predicted w Mean = 0.01 and Standard Deviation = 0.01



Actual and Predicted w_z for Wind Angle = 120 with a cut at Z=50m and X=480m

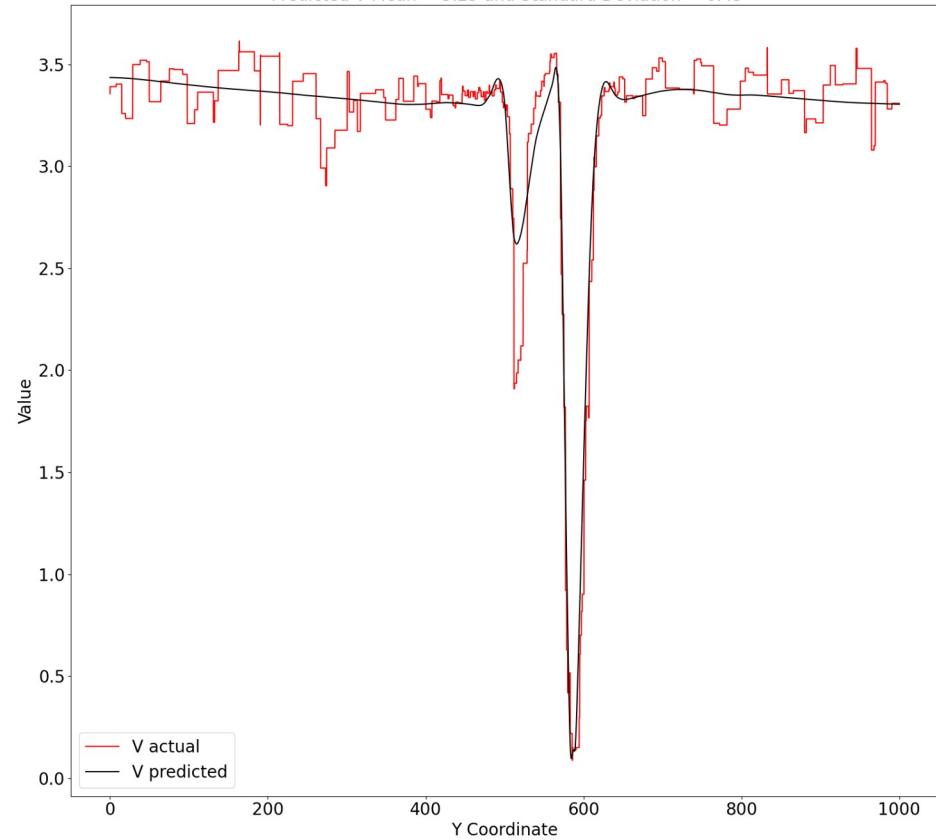
Actual w_z Mean = 0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.01

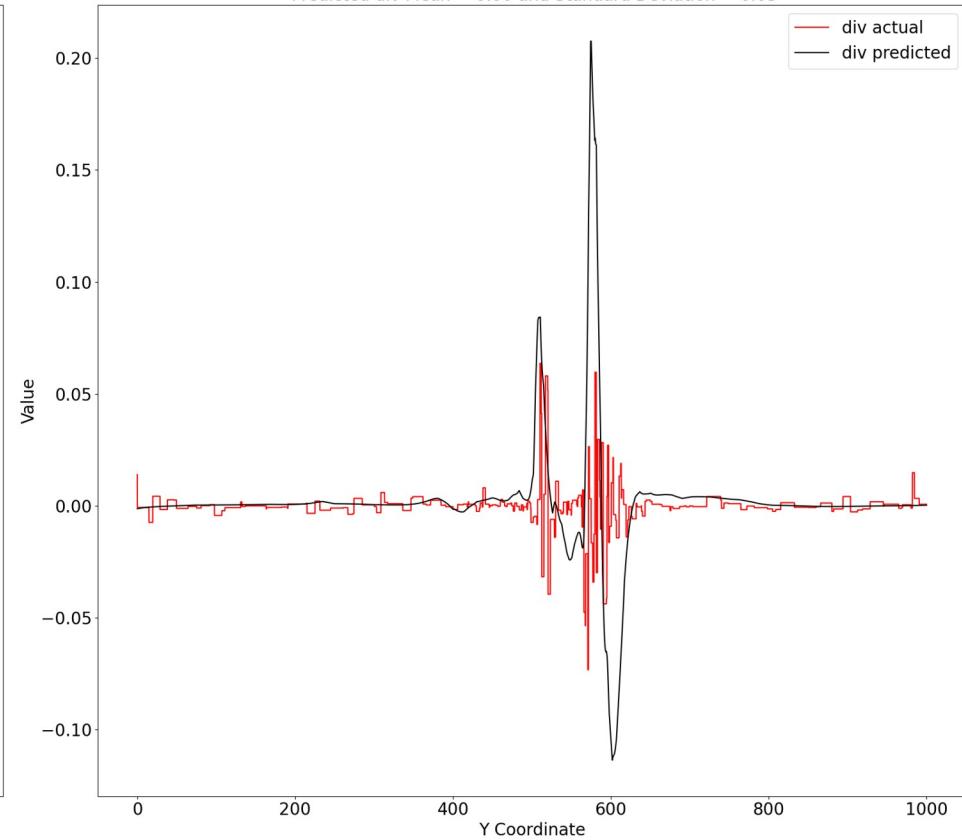


Comparison of Actual vs. Predicted values with Wind Angle = 135

Actual and Predicted V for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual V Mean = 3.25 and Standard Deviation = 0.51
Predicted V Mean = 3.25 and Standard Deviation = 0.45



Actual and Predicted div for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.03

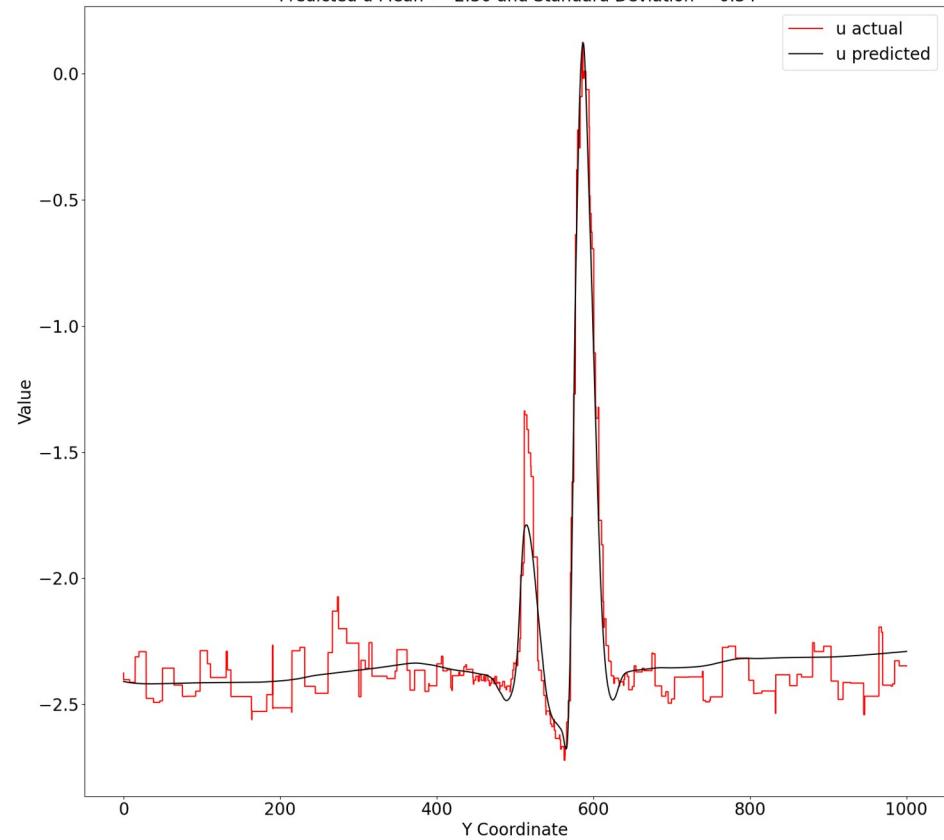


Comparison of Actual vs. Predicted values with Wind Angle = 135

Actual and Predicted u for Wind Angle = 135 with a cut at Z=50m and X=480m

Actual u Mean = -2.32 and Standard Deviation = 0.37

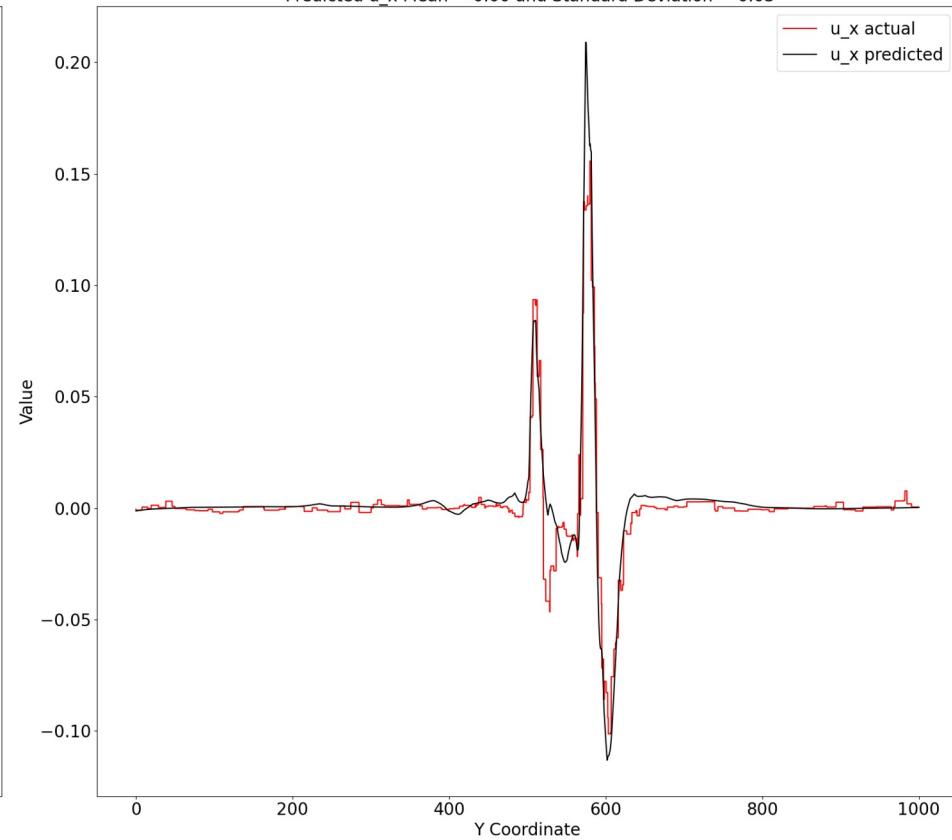
Predicted u Mean = -2.30 and Standard Deviation = 0.34



Actual and Predicted u_x for Wind Angle = 135 with a cut at Z=50m and X=480m

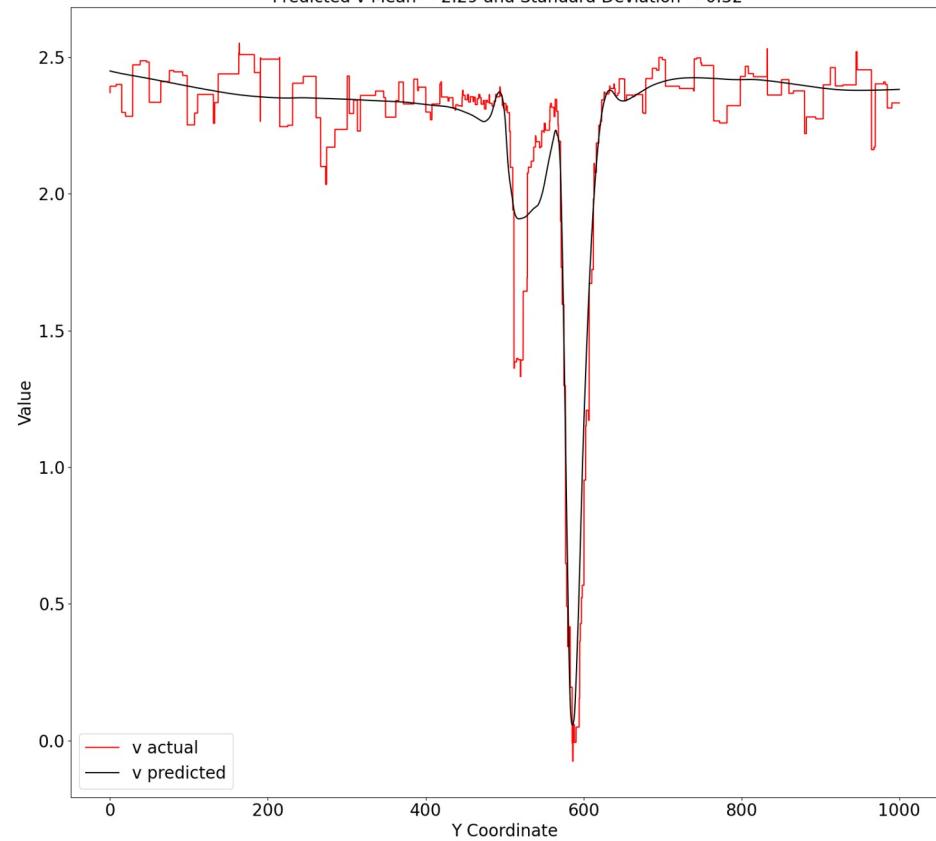
Actual u_x Mean = 0.00 and Standard Deviation = 0.02

Predicted u_x Mean = 0.00 and Standard Deviation = 0.03

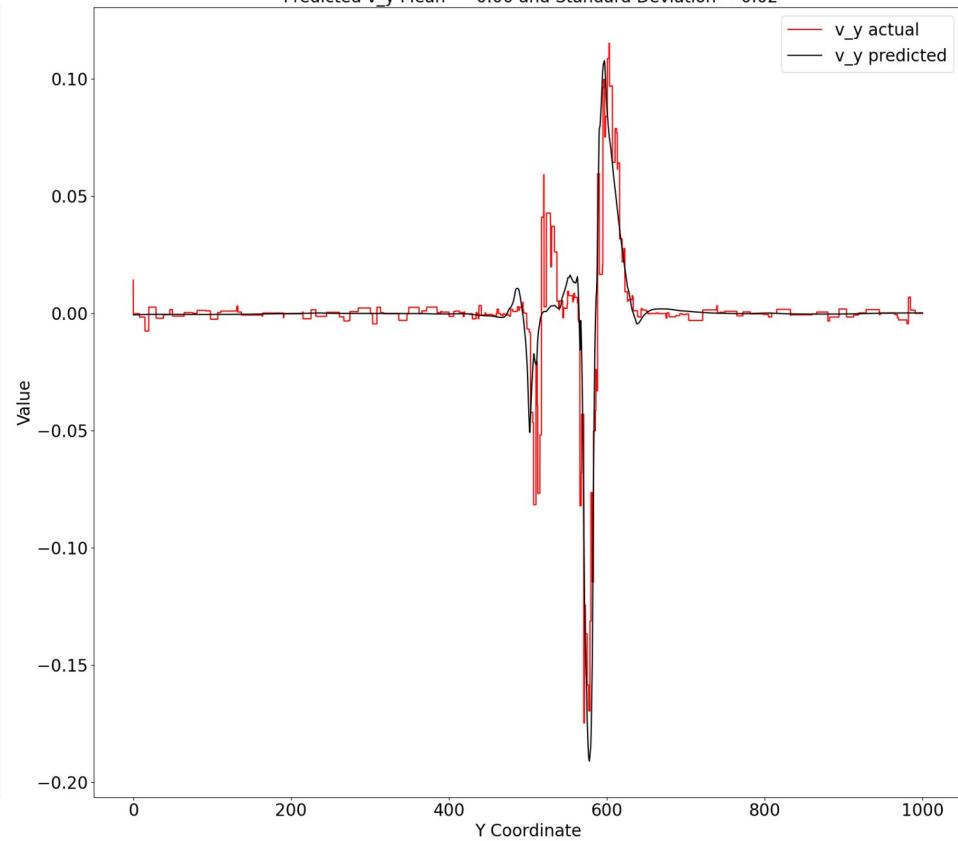


Comparison of Actual vs. Predicted values with Wind Angle = 135

Actual and Predicted v for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual v Mean = 2.28 and Standard Deviation = 0.37
Predicted v Mean = 2.29 and Standard Deviation = 0.32

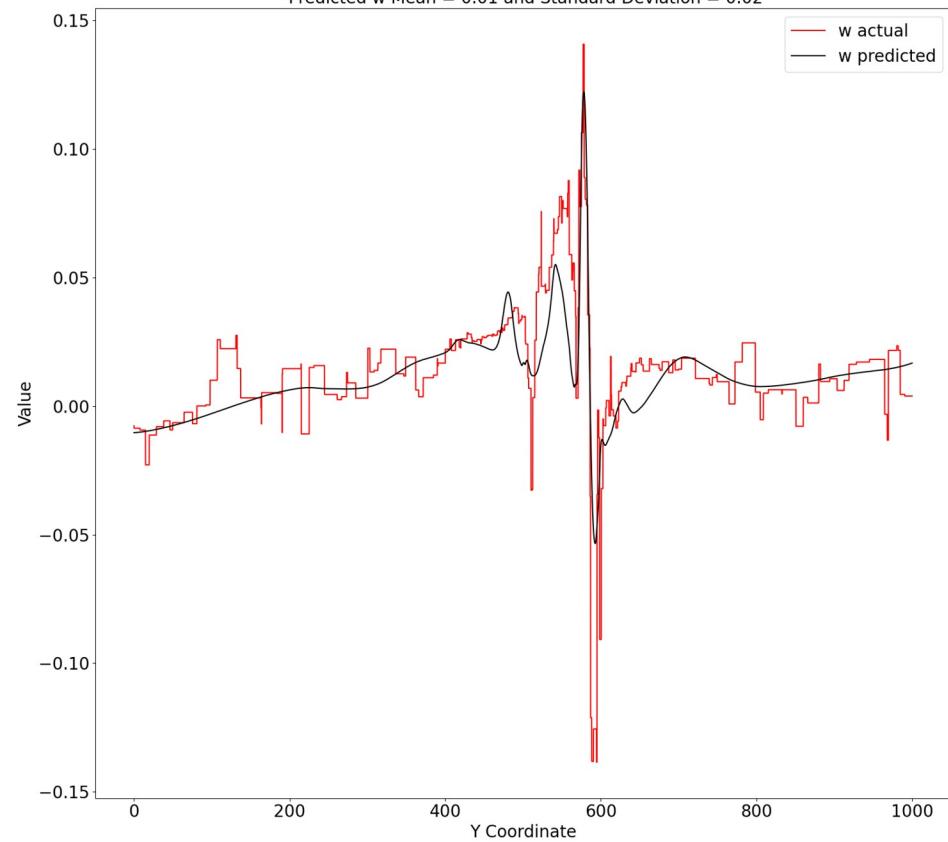


Actual and Predicted v_y for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.02
Predicted v_y Mean = -0.00 and Standard Deviation = 0.02

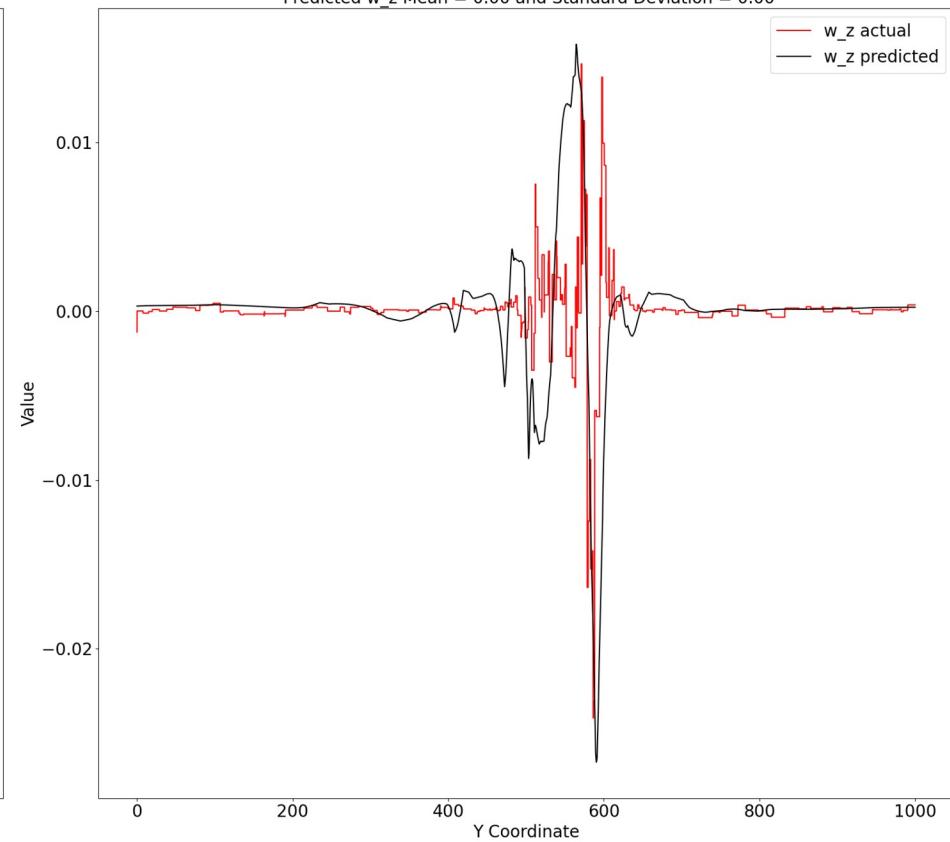


Comparison of Actual vs. Predicted values with Wind Angle = 135

Actual and Predicted w for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual w Mean = 0.01 and Standard Deviation = 0.02
Predicted w Mean = 0.01 and Standard Deviation = 0.02

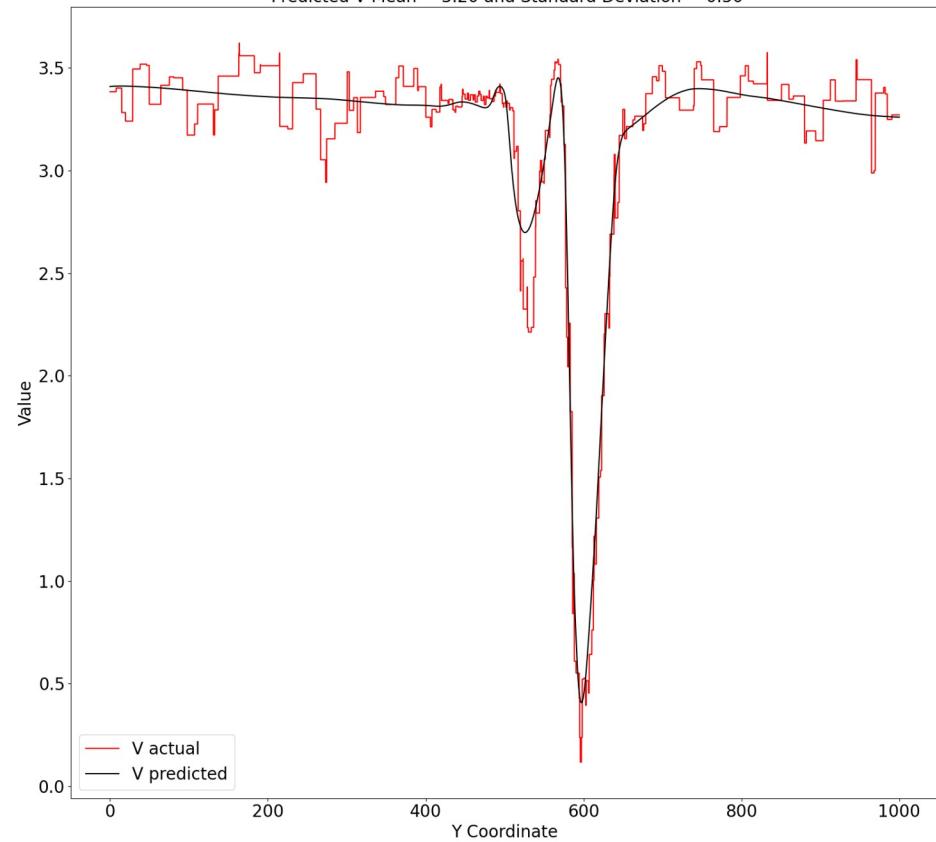


Actual and Predicted w_z for Wind Angle = 135 with a cut at Z=50m and X=480m
Actual w_z Mean = 0.00 and Standard Deviation = 0.00
Predicted w_z Mean = 0.00 and Standard Deviation = 0.00

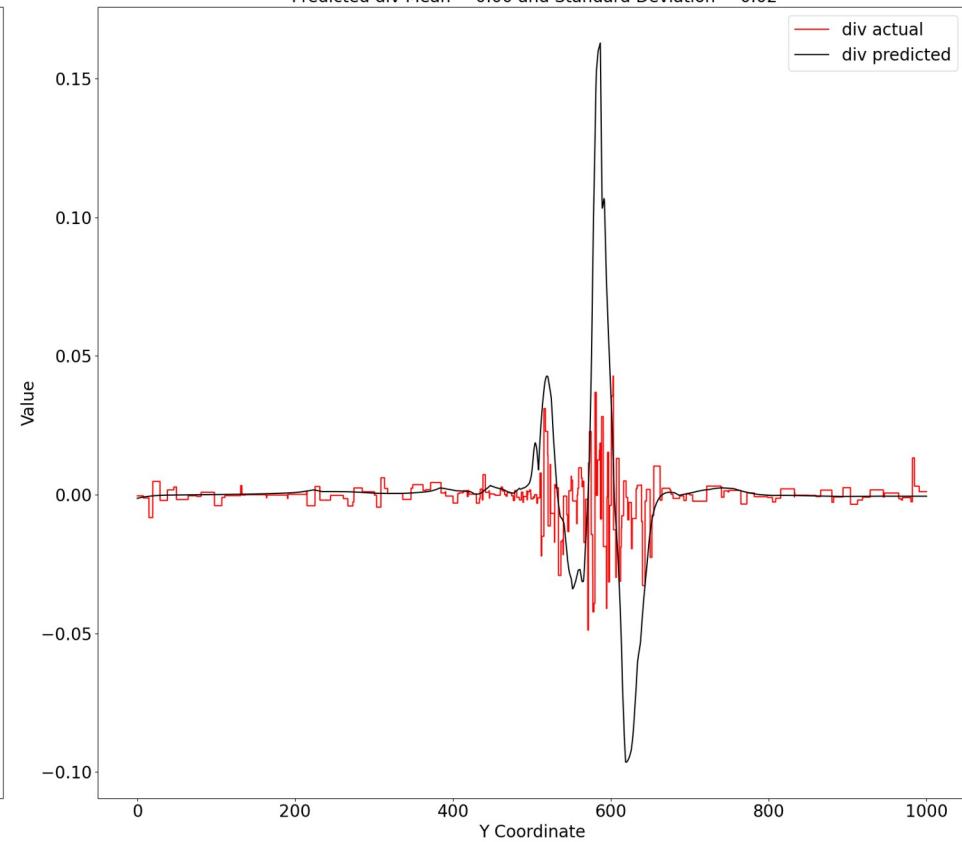


Comparison of Actual vs. Predicted values with Wind Angle = 150

Actual and Predicted V for Wind Angle = 150 with a cut at Z=50m and X=480m
Actual V Mean = 3.20 and Standard Deviation = 0.55
Predicted V Mean = 3.20 and Standard Deviation = 0.50

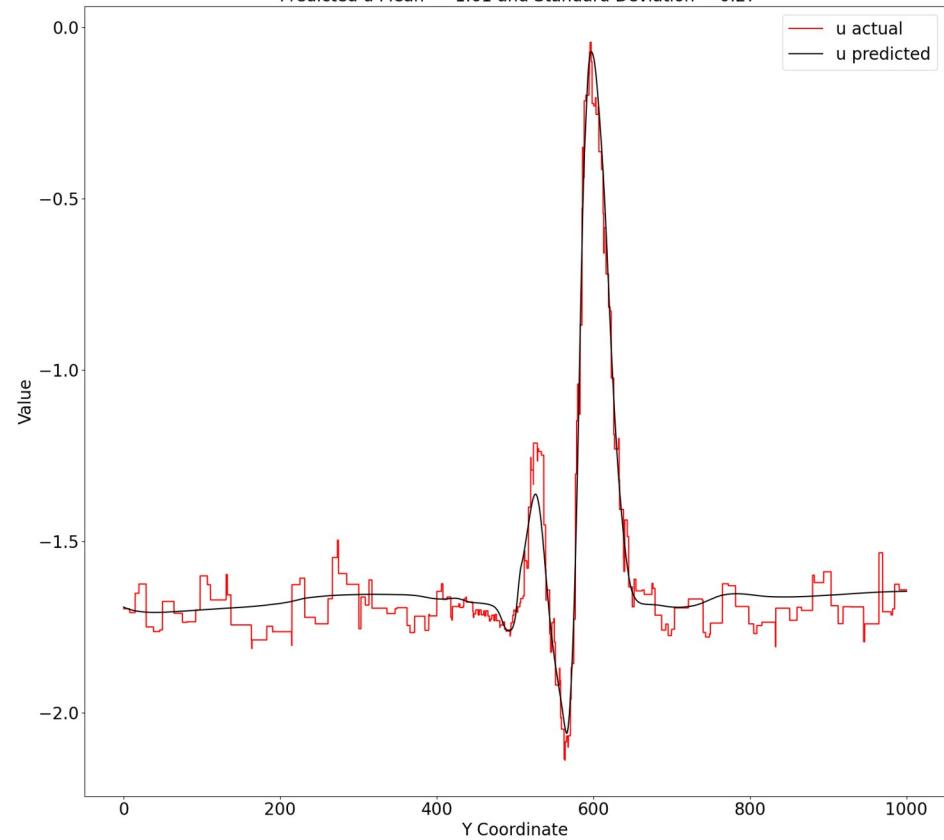


Actual and Predicted div for Wind Angle = 150 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.02

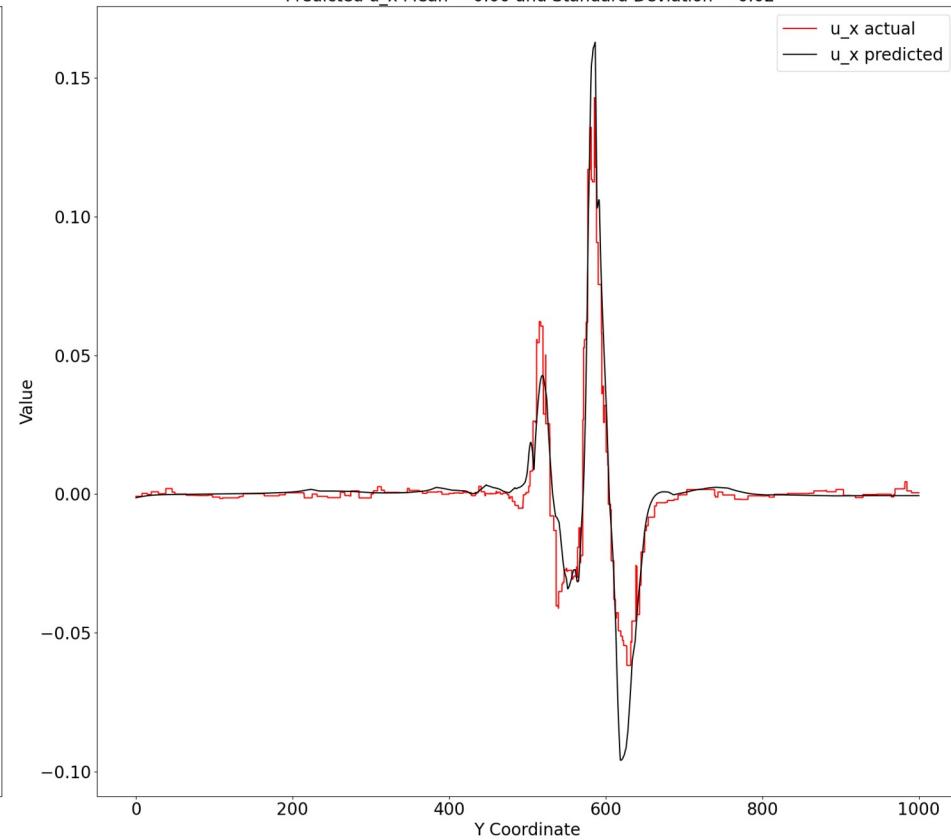


Comparison of Actual vs. Predicted values with Wind Angle = 150

Actual and Predicted u for Wind Angle = 150 with a cut at Z=50m and X=480m
 Actual u Mean = -1.63 and Standard Deviation = 0.28
 Predicted u Mean = -1.61 and Standard Deviation = 0.27

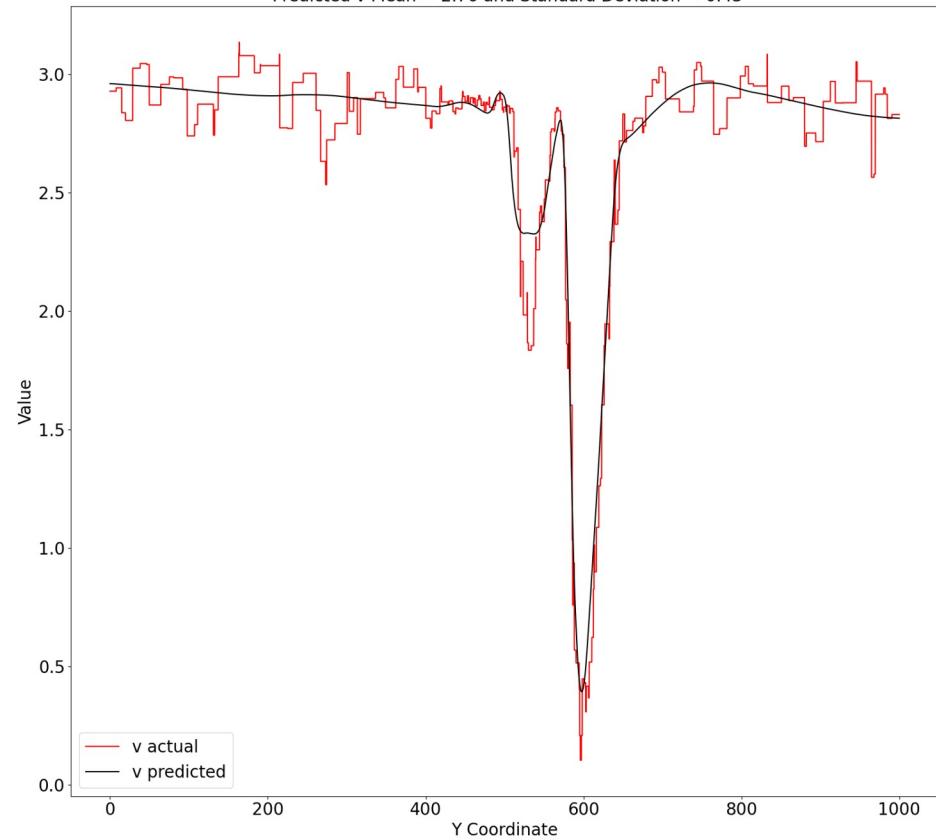


Actual and Predicted u_x for Wind Angle = 150 with a cut at Z=50m and X=480m
 Actual u_x Mean = 0.00 and Standard Deviation = 0.02
 Predicted u_x Mean = 0.00 and Standard Deviation = 0.02

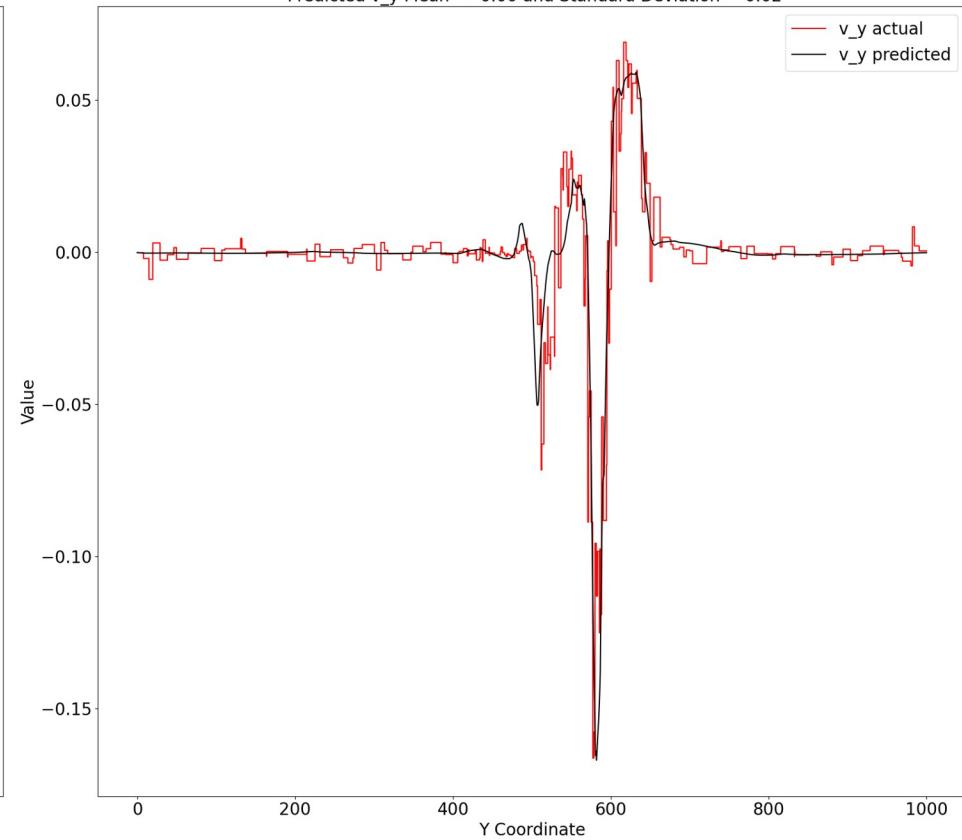


Comparison of Actual vs. Predicted values with Wind Angle = 150

Actual and Predicted v for Wind Angle = 150 with a cut at Z=50m and X=480m
Actual v Mean = 2.75 and Standard Deviation = 0.48
Predicted v Mean = 2.76 and Standard Deviation = 0.43



Actual and Predicted v_y for Wind Angle = 150 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.02
Predicted v_y Mean = -0.00 and Standard Deviation = 0.02

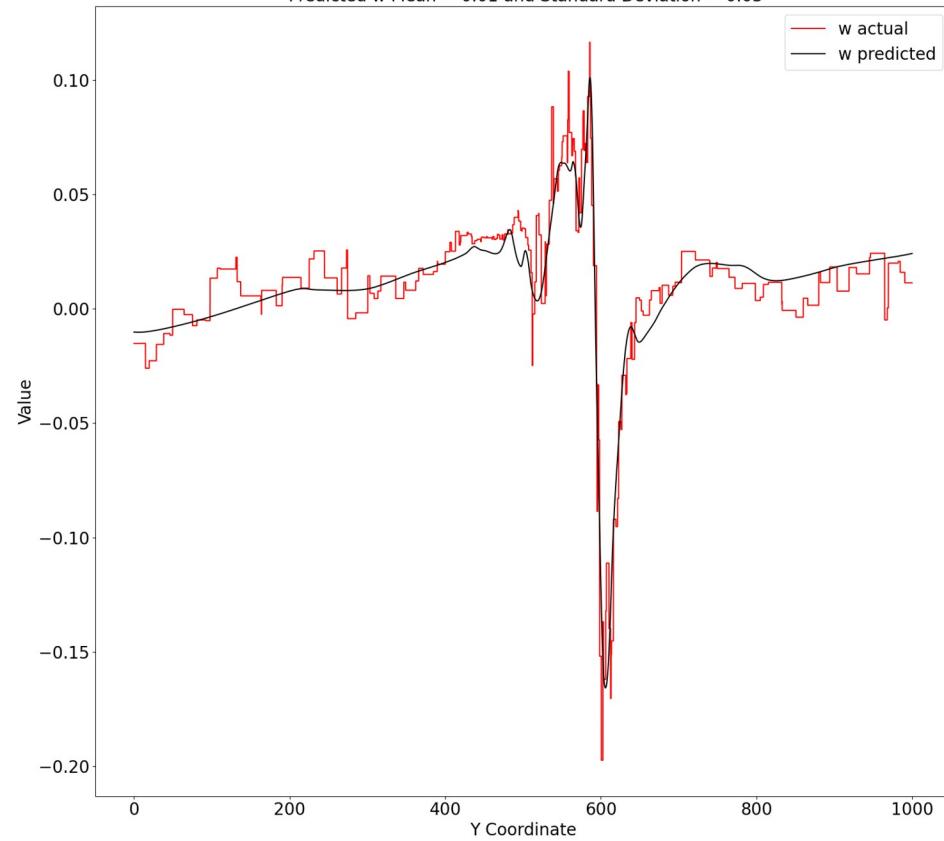


Comparison of Actual vs. Predicted values with Wind Angle = 150

Actual and Predicted w for Wind Angle = 150 with a cut at Z=50m and X=480m

Actual w Mean = 0.01 and Standard Deviation = 0.03

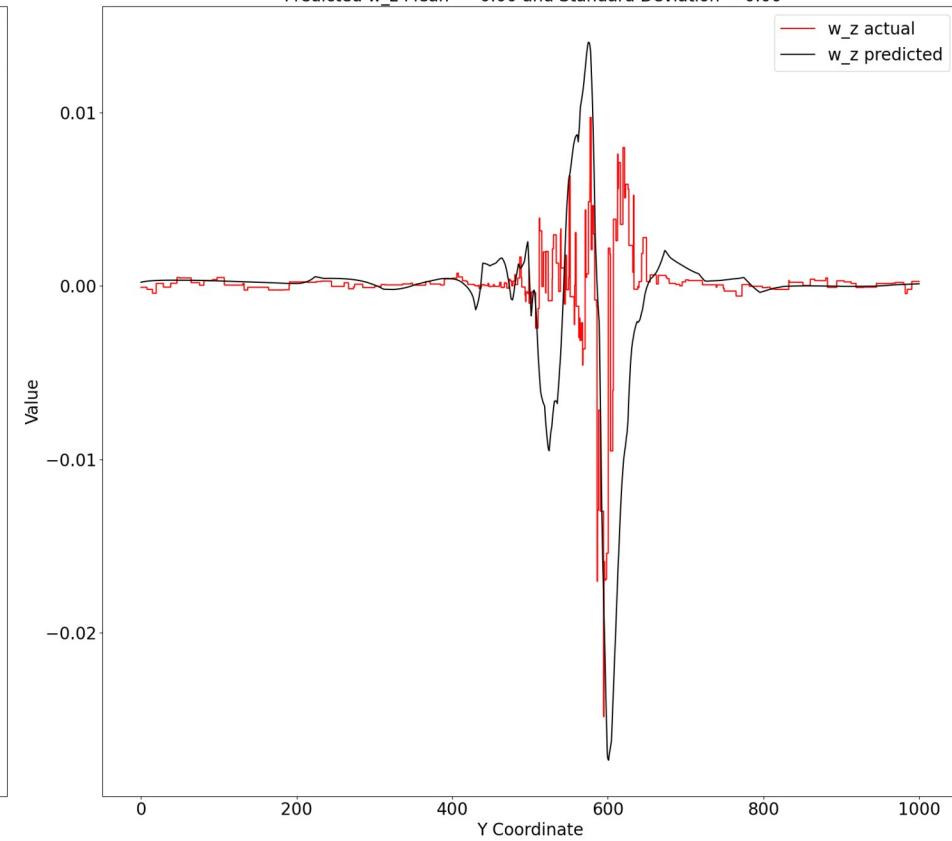
Predicted w Mean = 0.01 and Standard Deviation = 0.03



Actual and Predicted w_z for Wind Angle = 150 with a cut at Z=50m and X=480m

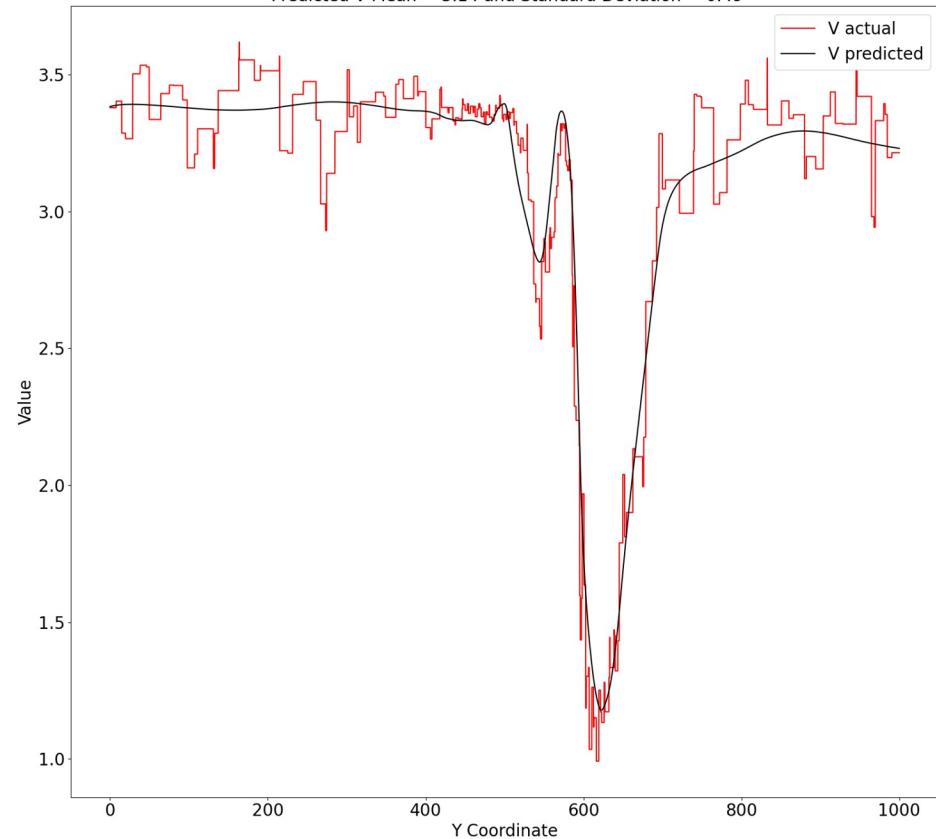
Actual w_z Mean = 0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

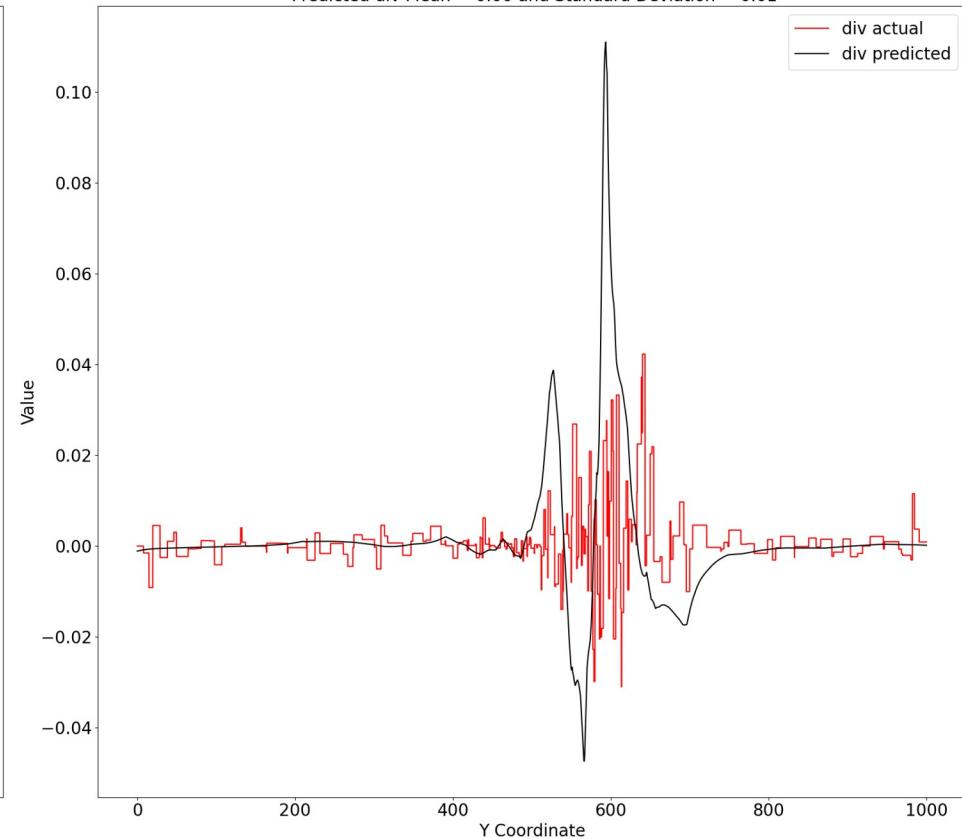


Comparison of Actual vs. Predicted values with Wind Angle = 165

Actual and Predicted V for Wind Angle = 165 with a cut at Z=50m and X=480m
Actual V Mean = 3.15 and Standard Deviation = 0.53
Predicted V Mean = 3.14 and Standard Deviation = 0.49



Actual and Predicted div for Wind Angle = 165 with a cut at Z=50m and X=480m
Actual div Mean = 0.00 and Standard Deviation = 0.01
Predicted div Mean = 0.00 and Standard Deviation = 0.01

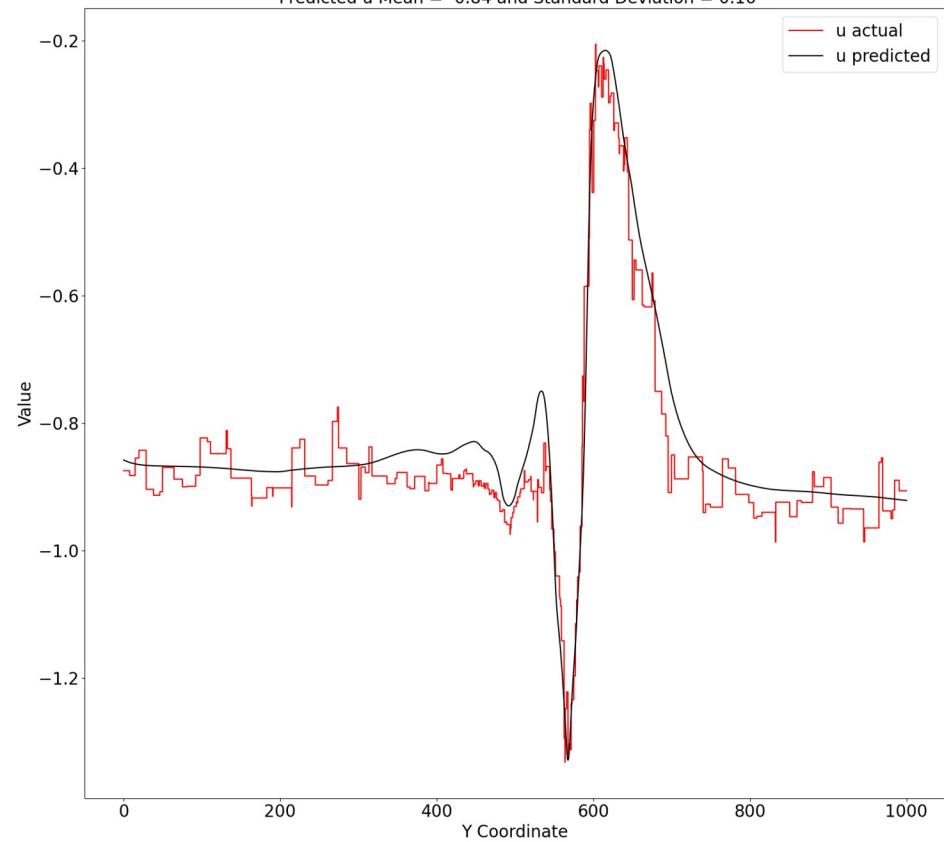


Comparison of Actual vs. Predicted values with Wind Angle = 165

Actual and Predicted u for Wind Angle = 165 with a cut at Z=50m and X=480m

Actual u Mean = -0.86 and Standard Deviation = 0.15

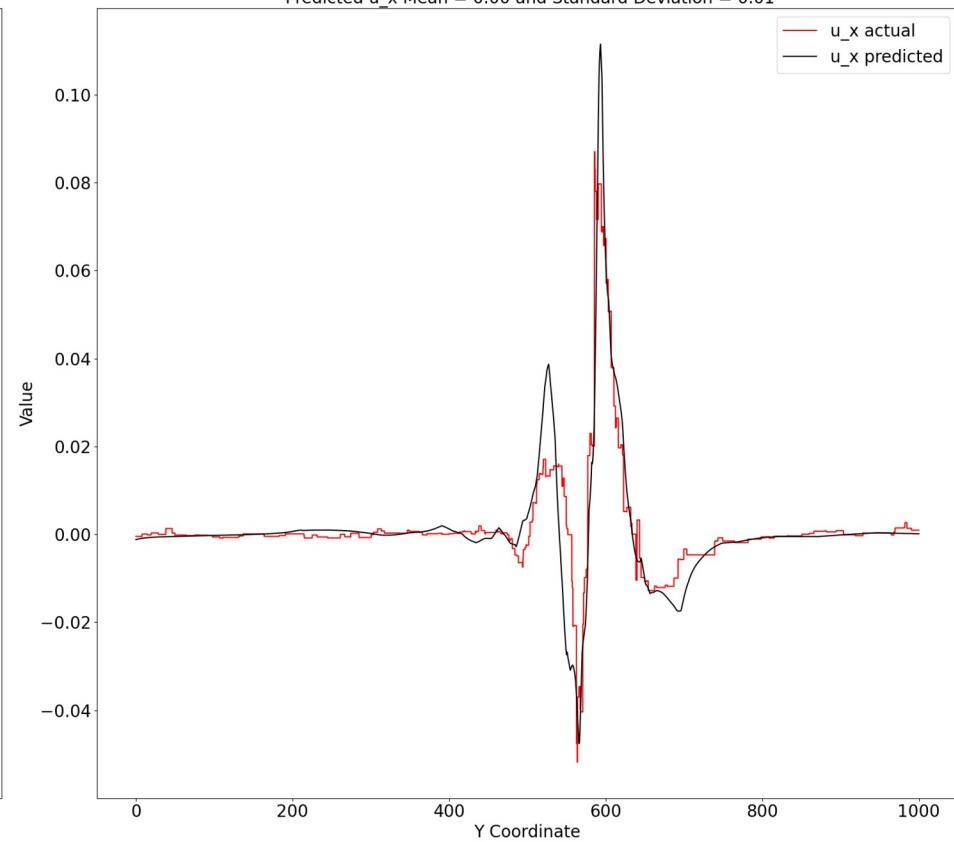
Predicted u Mean = -0.84 and Standard Deviation = 0.16



Actual and Predicted u_x for Wind Angle = 165 with a cut at Z=50m and X=480m

Actual u_x Mean = 0.00 and Standard Deviation = 0.01

Predicted u_x Mean = 0.00 and Standard Deviation = 0.01

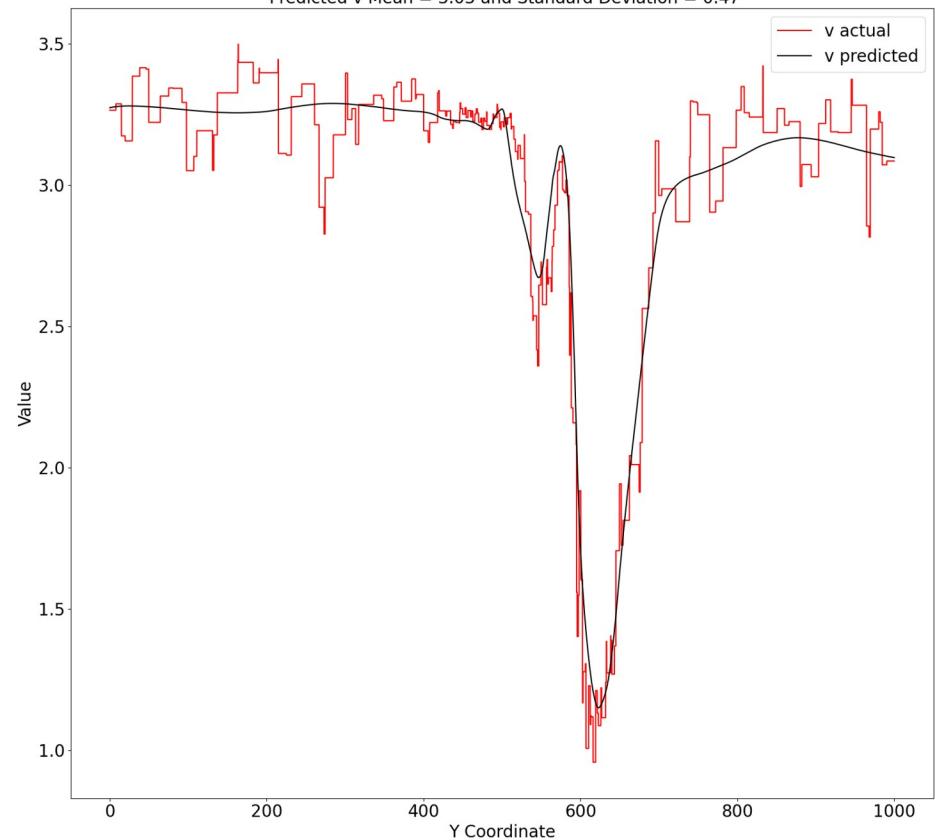


Comparison of Actual vs. Predicted values with Wind Angle = 165

Actual and Predicted v for Wind Angle = 165 with a cut at Z=50m and X=480m

Actual v Mean = 3.03 and Standard Deviation = 0.51

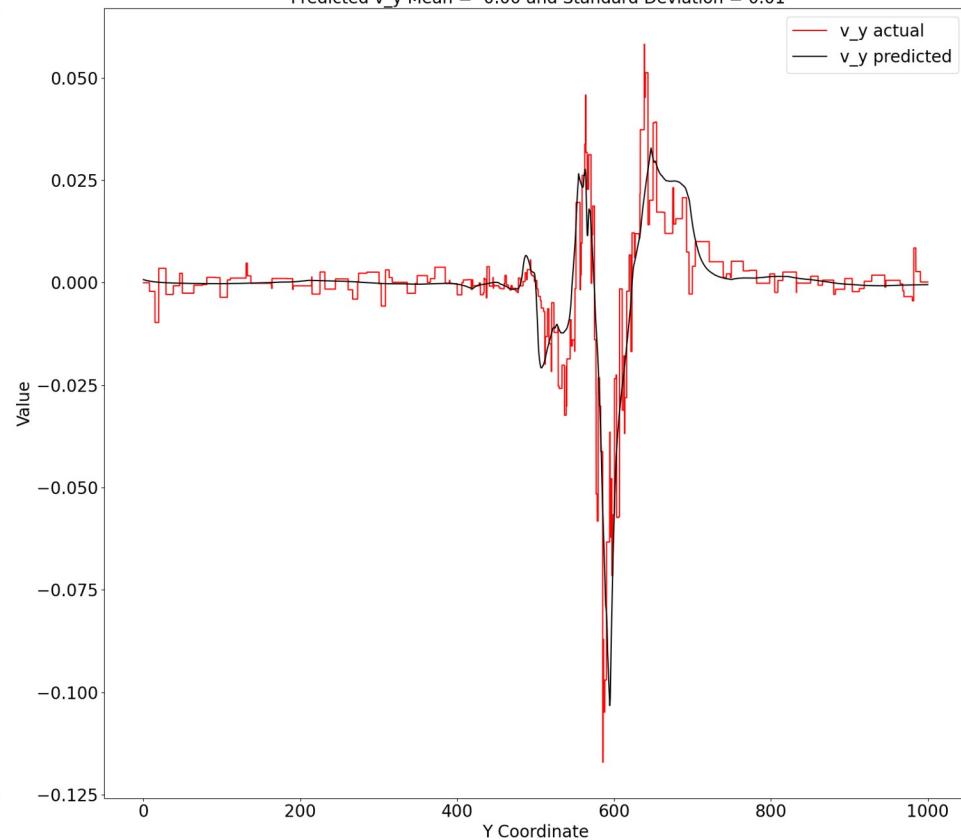
Predicted v Mean = 3.03 and Standard Deviation = 0.47



Actual and Predicted v_y for Wind Angle = 165 with a cut at Z=50m and X=480m

Actual v_y Mean = -0.00 and Standard Deviation = 0.01

Predicted v_y Mean = -0.00 and Standard Deviation = 0.01



Comparison of Actual vs. Predicted values with Wind Angle = 165

Actual and Predicted w for Wind Angle = 165 with a cut at Z=50m and X=480m

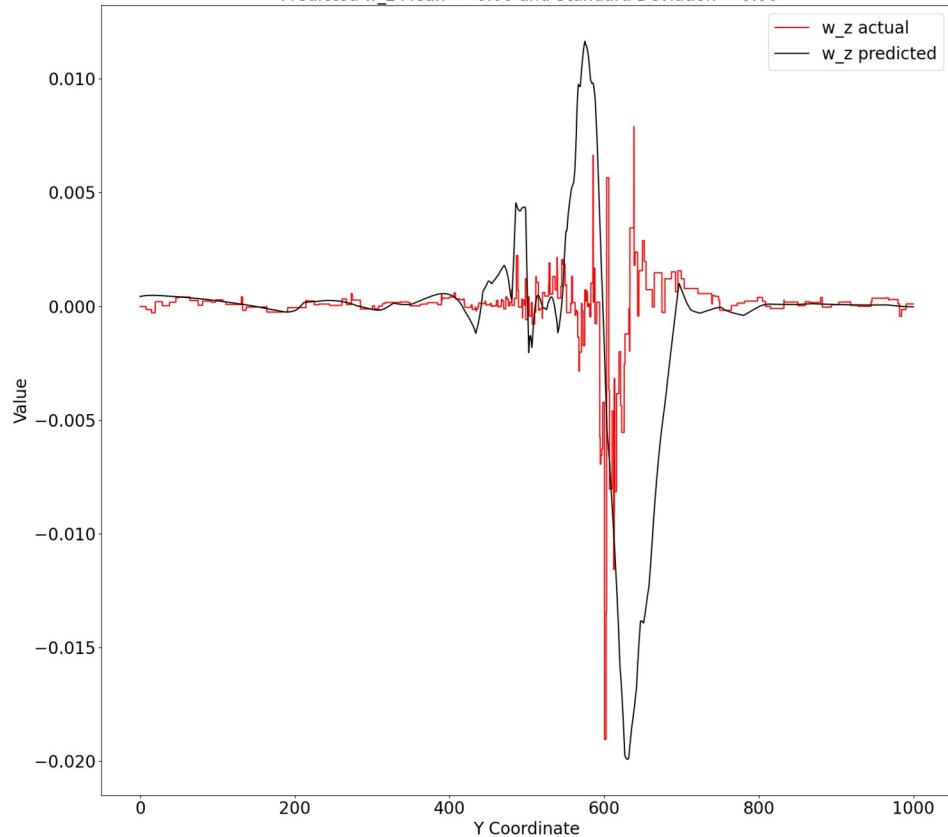
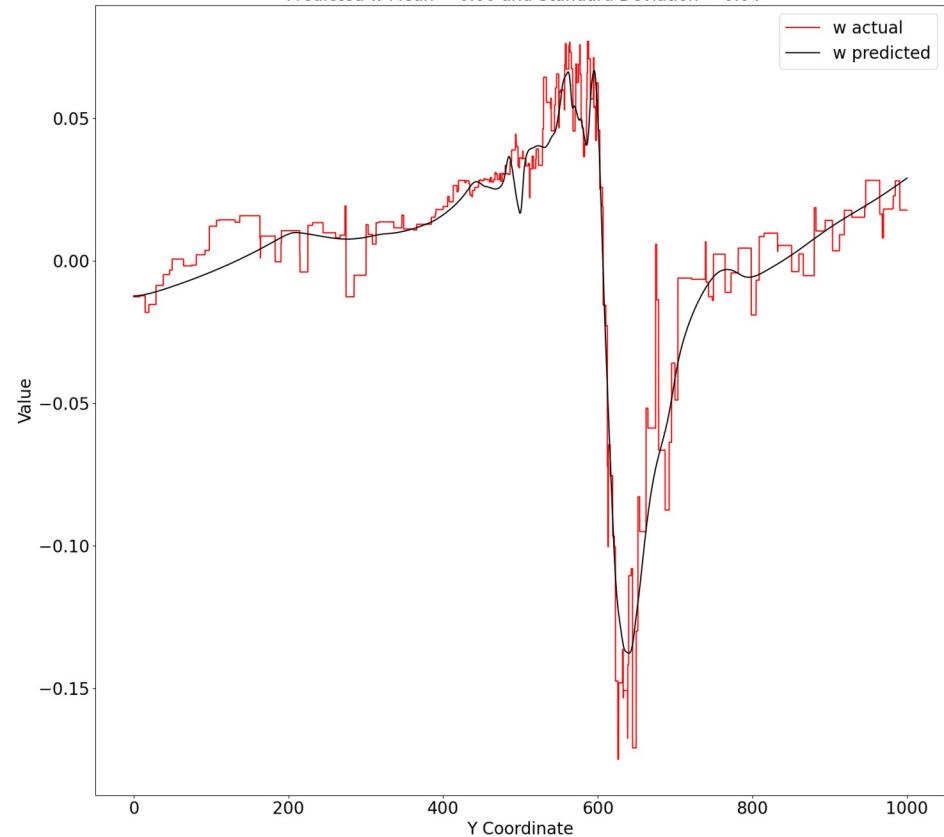
Actual w Mean = 0.00 and Standard Deviation = 0.04

Predicted w Mean = 0.00 and Standard Deviation = 0.04

Actual and Predicted w_z for Wind Angle = 165 with a cut at Z=50m and X=480m

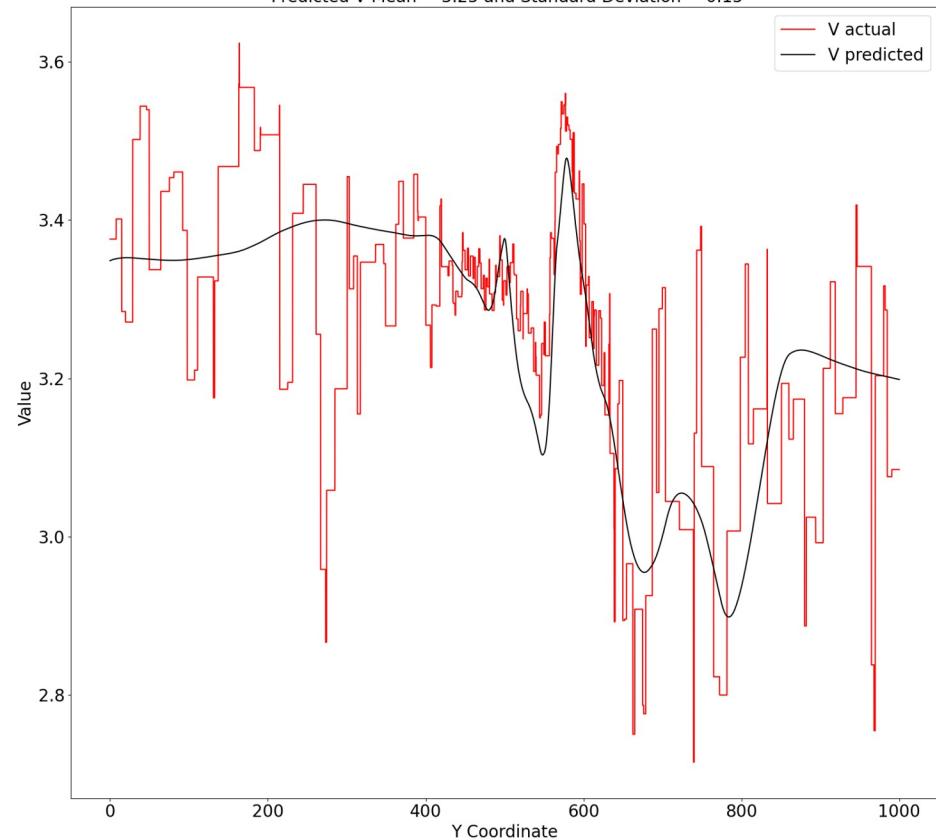
Actual w_z Mean = 0.00 and Standard Deviation = 0.00

Predicted w_z Mean = -0.00 and Standard Deviation = 0.00

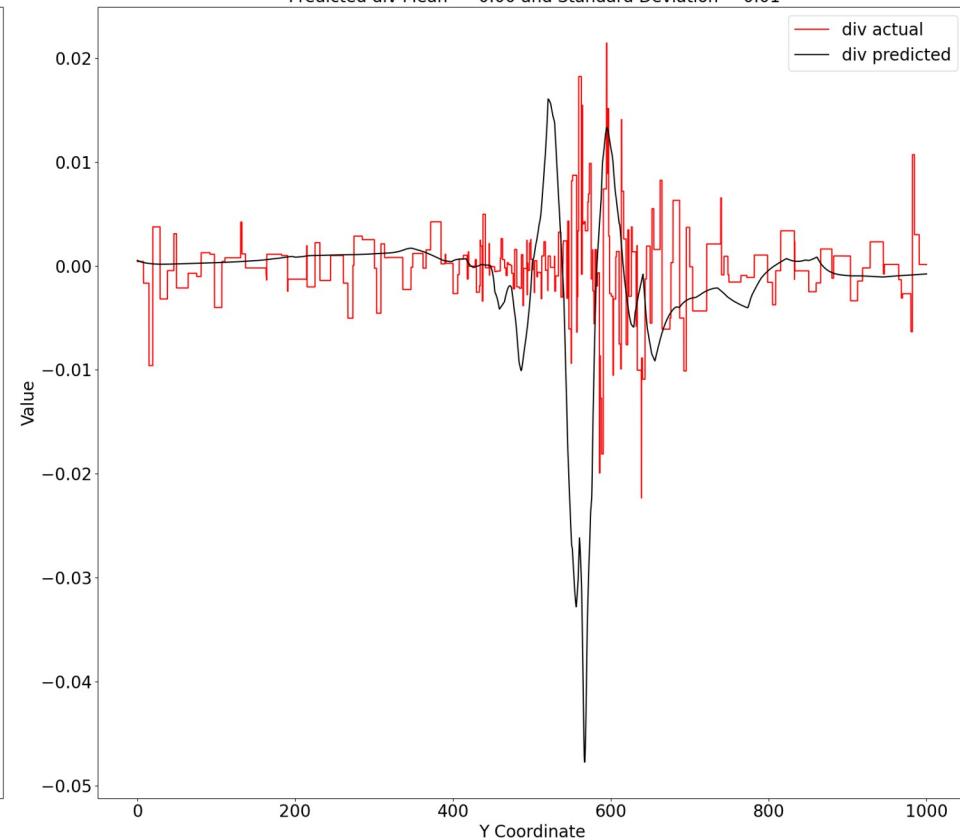


Comparison of Actual vs. Predicted values with Wind Angle = 180

Actual and Predicted V for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual V Mean = 3.26 and Standard Deviation = 0.18
Predicted V Mean = 3.25 and Standard Deviation = 0.15

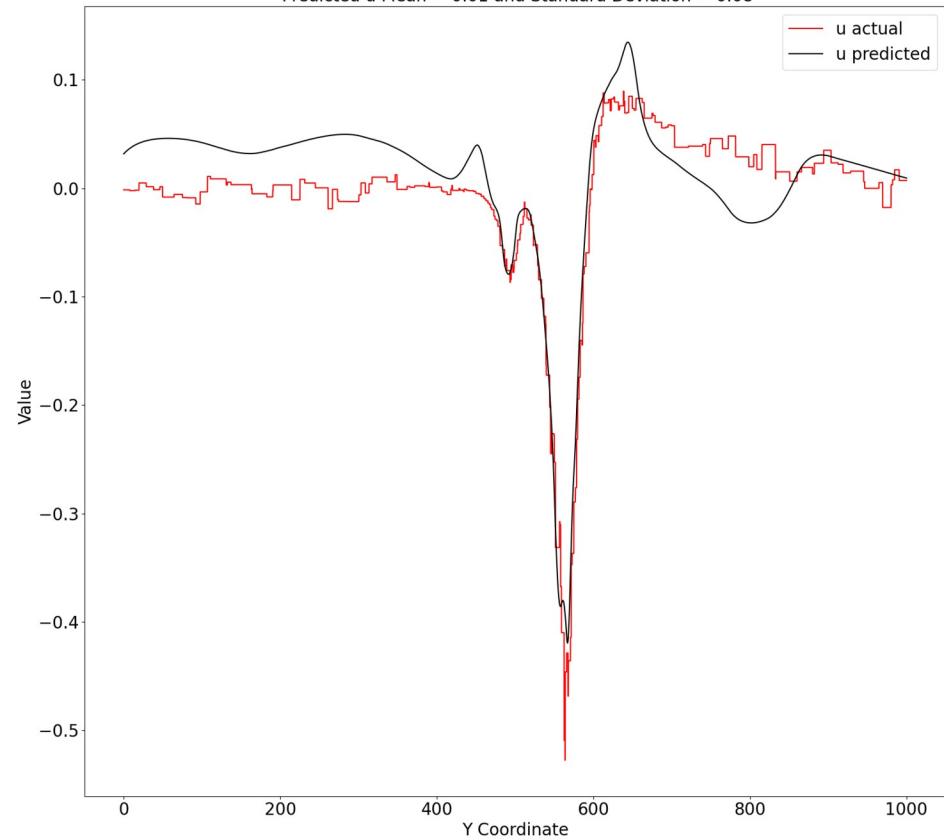


Actual and Predicted div for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual div Mean = -0.00 and Standard Deviation = 0.00
Predicted div Mean = -0.00 and Standard Deviation = 0.01

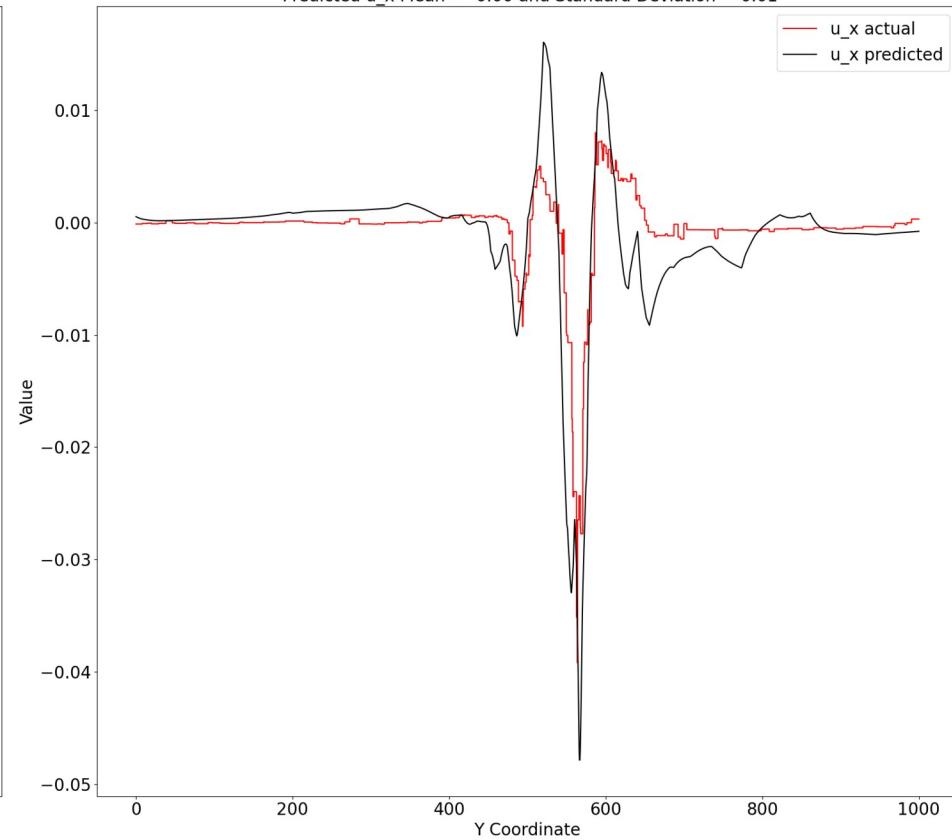


Comparison of Actual vs. Predicted values with Wind Angle = 180

Actual and Predicted u for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual u Mean = -0.00 and Standard Deviation = 0.08
Predicted u Mean = 0.01 and Standard Deviation = 0.08

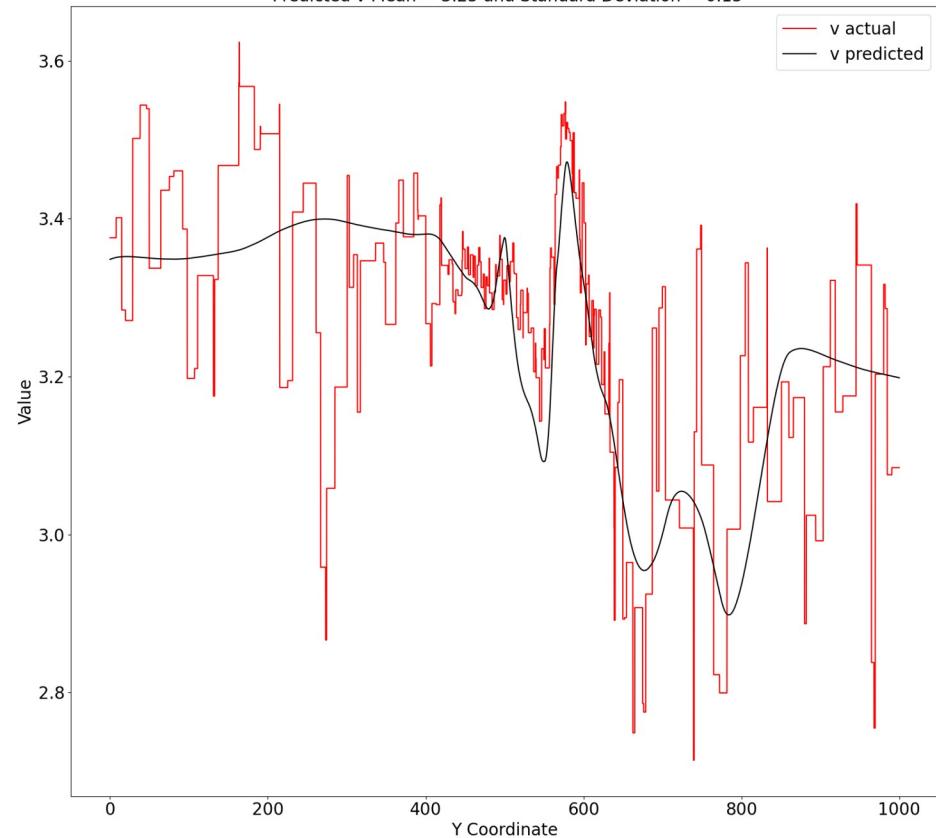


Actual and Predicted u_x for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual u_x Mean = -0.00 and Standard Deviation = 0.00
Predicted u_x Mean = -0.00 and Standard Deviation = 0.01

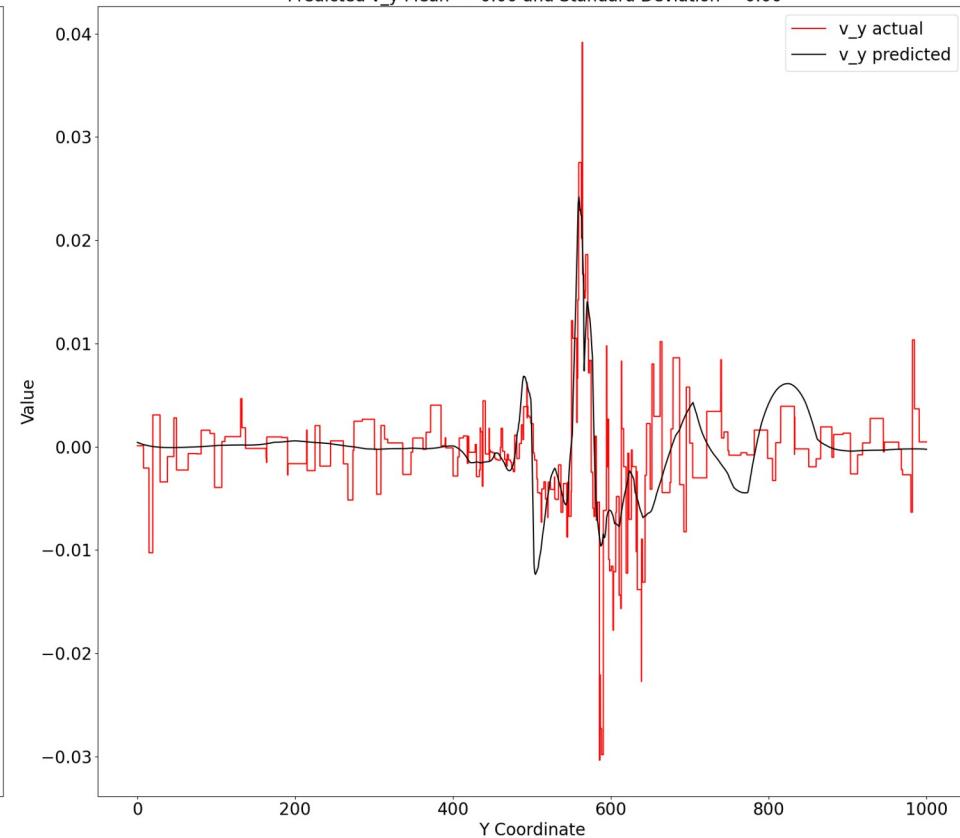


Comparison of Actual vs. Predicted values with Wind Angle = 180

Actual and Predicted v for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual v Mean = 3.26 and Standard Deviation = 0.18
Predicted v Mean = 3.25 and Standard Deviation = 0.15

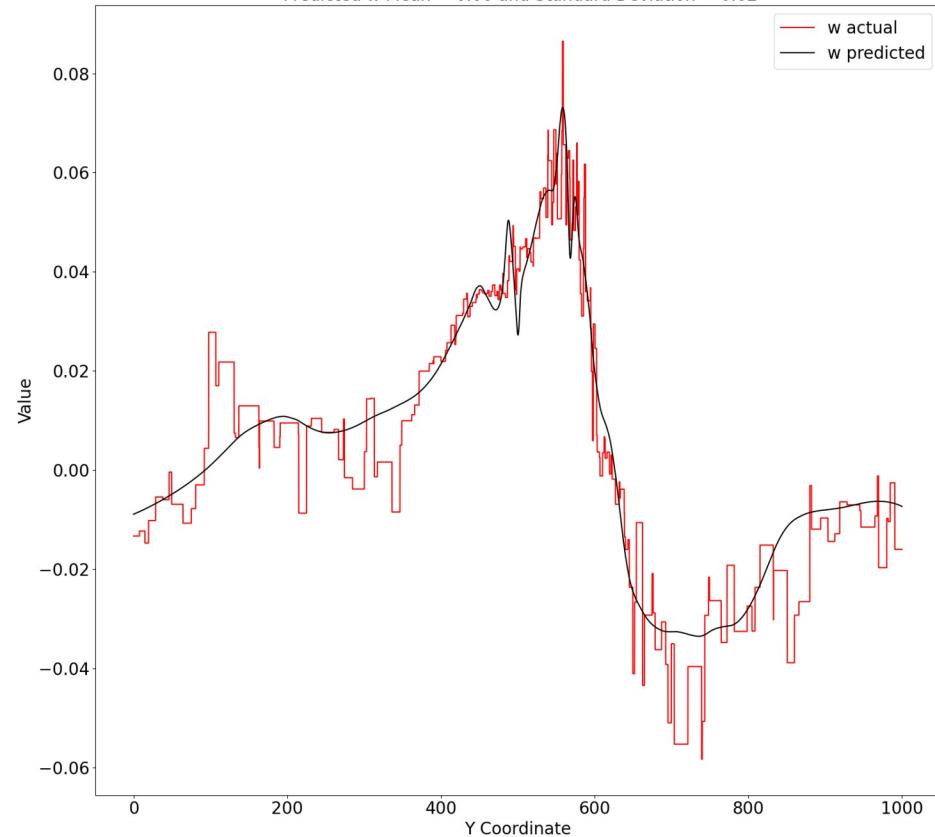


Actual and Predicted v_y for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual v_y Mean = -0.00 and Standard Deviation = 0.00
Predicted v_y Mean = -0.00 and Standard Deviation = 0.00

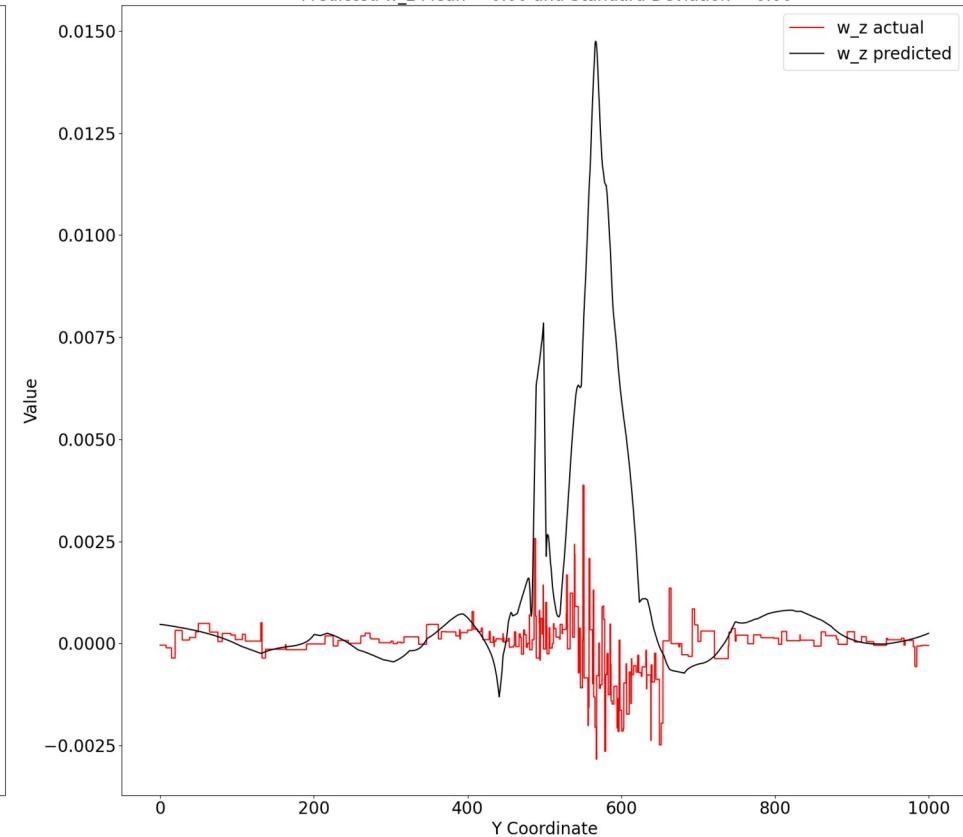


Comparison of Actual vs. Predicted values with Wind Angle = 180

Actual and Predicted w for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual w Mean = 0.00 and Standard Deviation = 0.03
Predicted w Mean = 0.00 and Standard Deviation = 0.02



Actual and Predicted w_z for Wind Angle = 180 with a cut at Z=50m and X=480m
Actual w_z Mean = 0.00 and Standard Deviation = 0.00
Predicted w_z Mean = 0.00 and Standard Deviation = 0.00

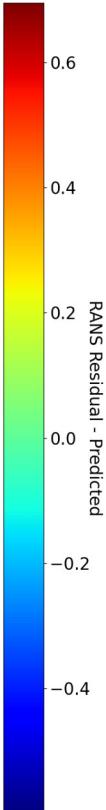
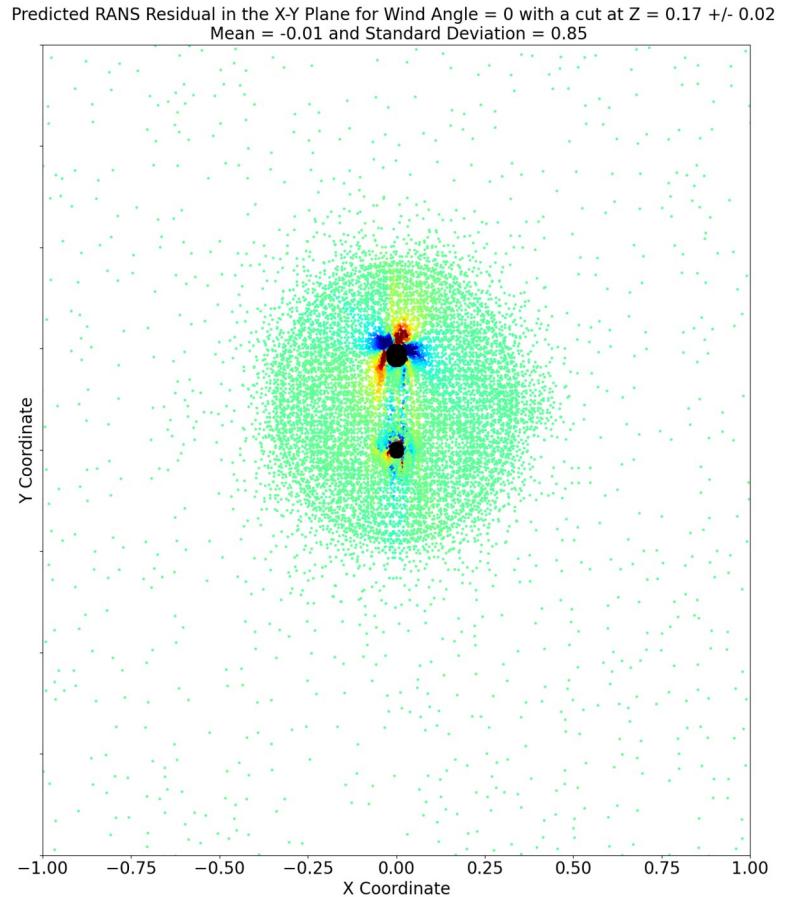
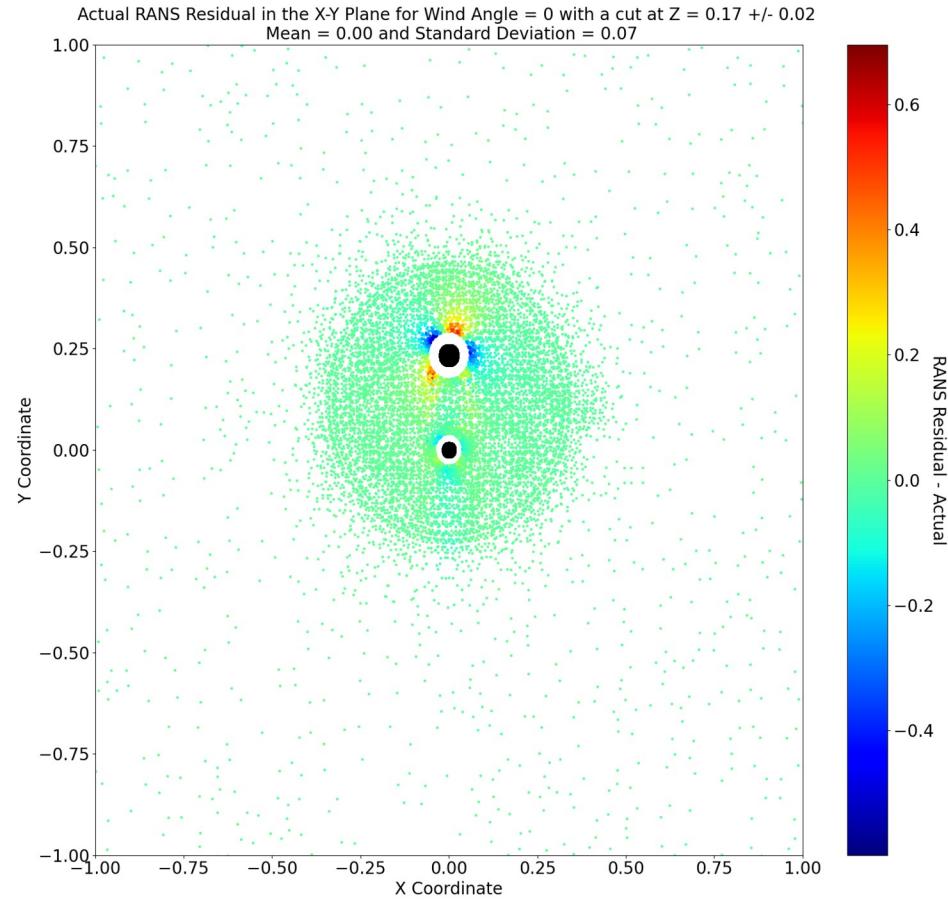


Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

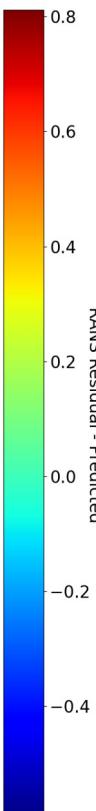
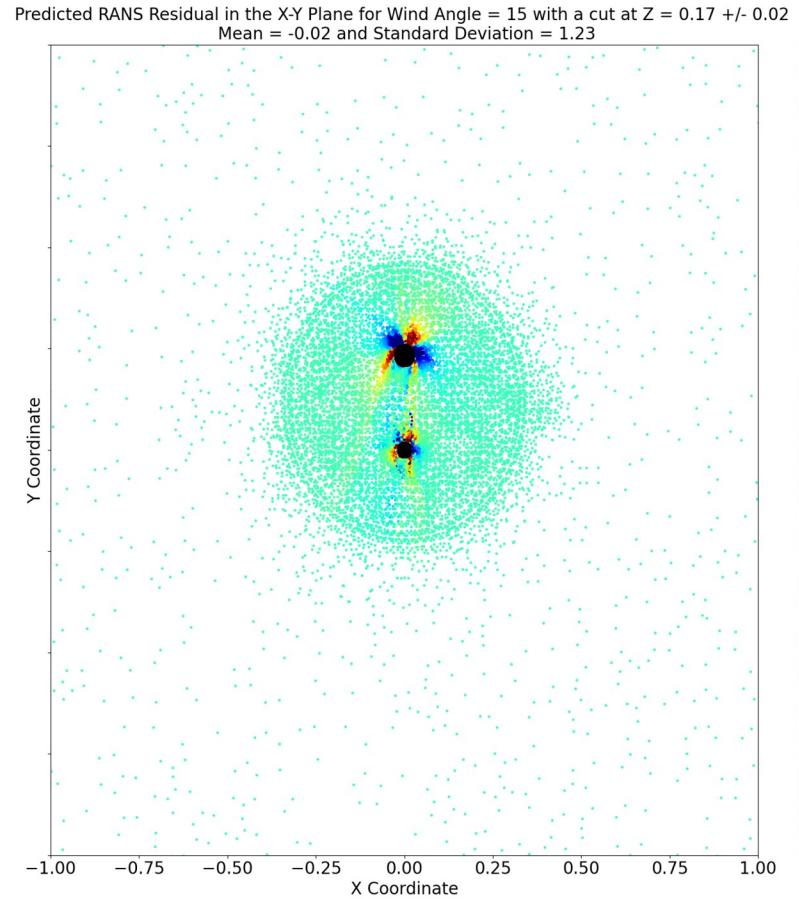
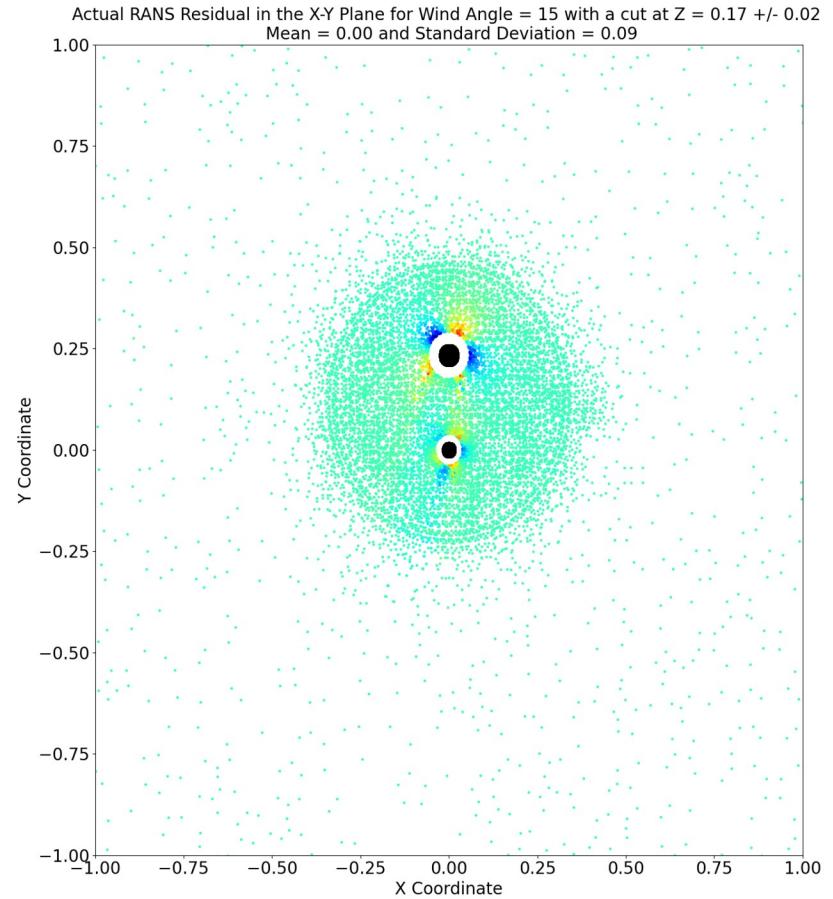
Threshold = SMA 1E-5 (10760 Epochs, not completed), GPU Laptop

Scripts v5 – RANS

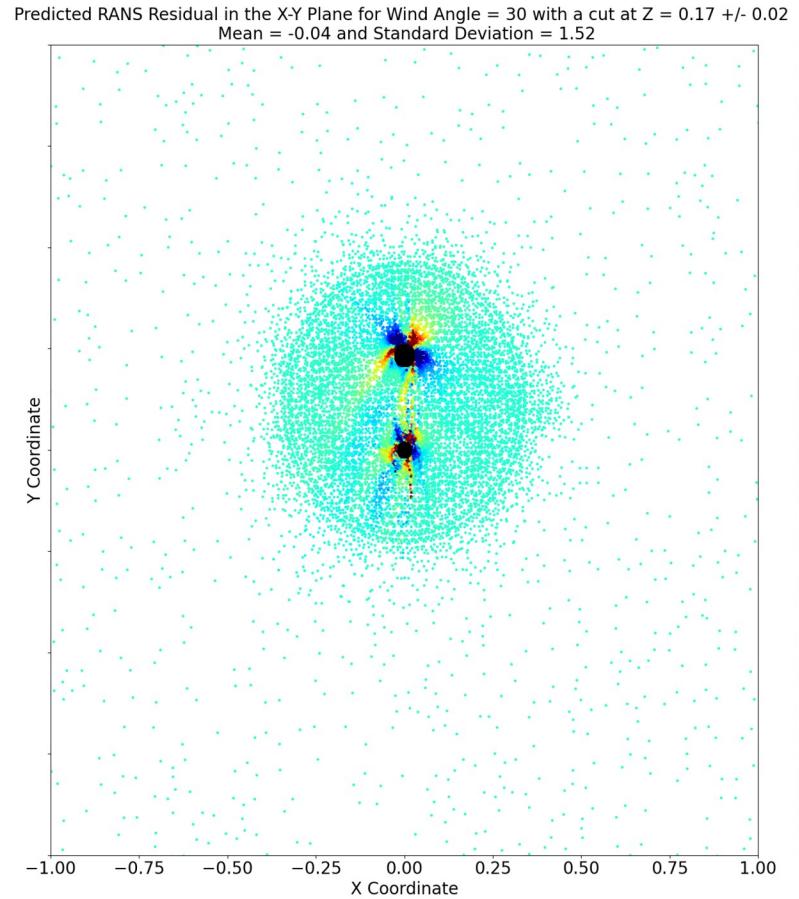
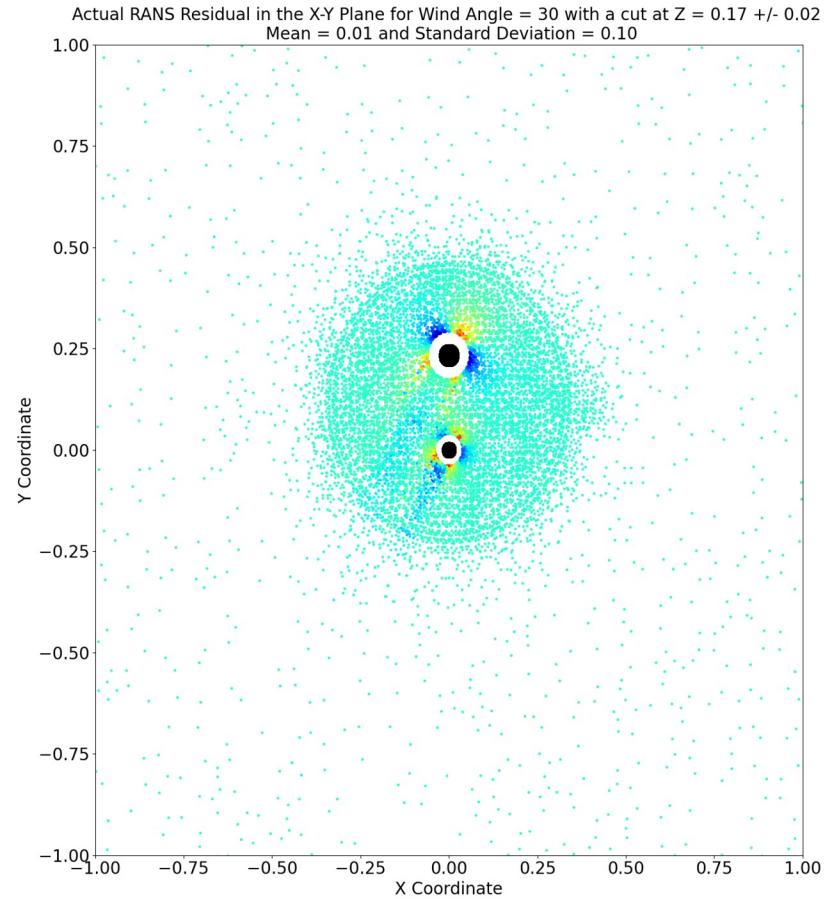
Comparison of Actual vs. Predicted values with Wind Angle = 0 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Comparison of Actual vs. Predicted values with Wind Angle = 15 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



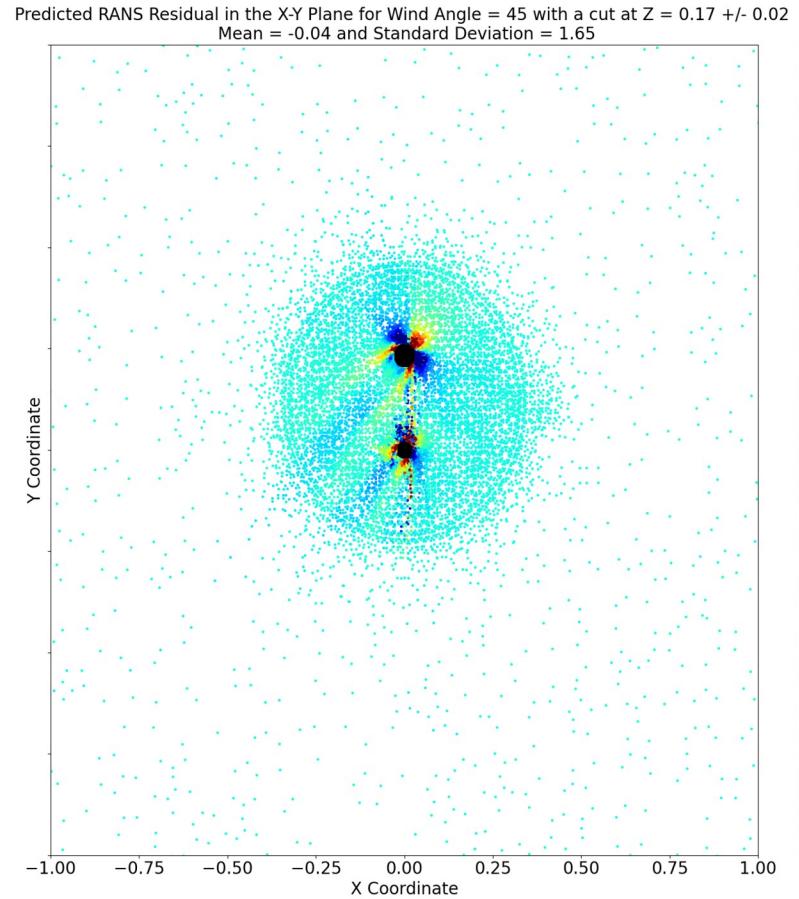
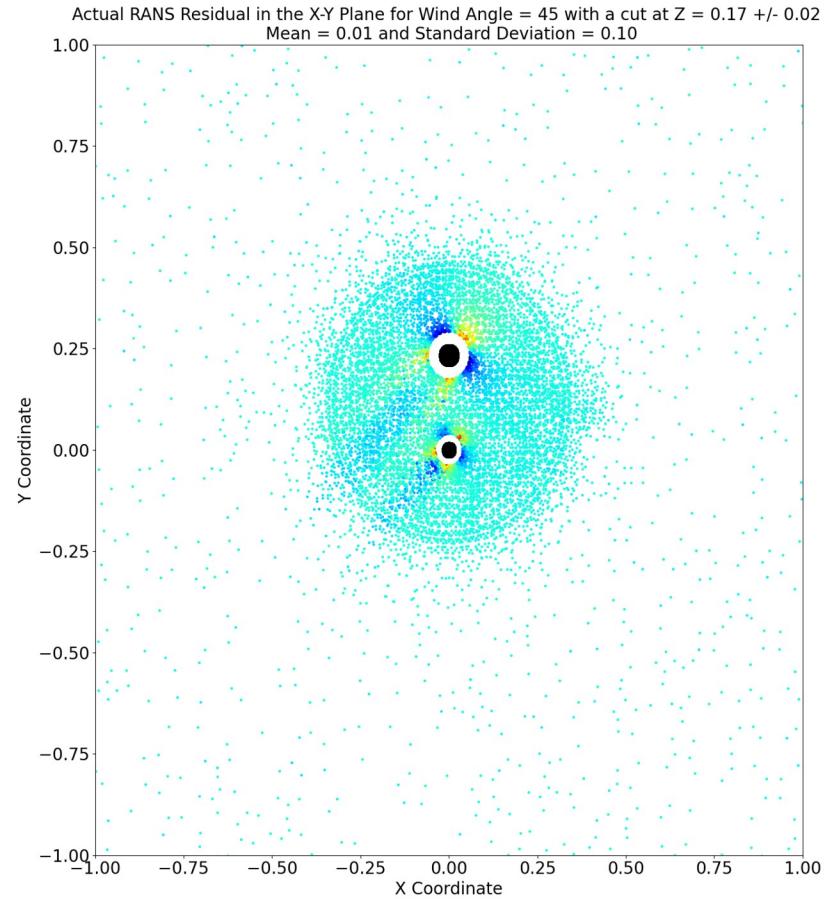
Comparison of Actual vs. Predicted values with Wind Angle = 30 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



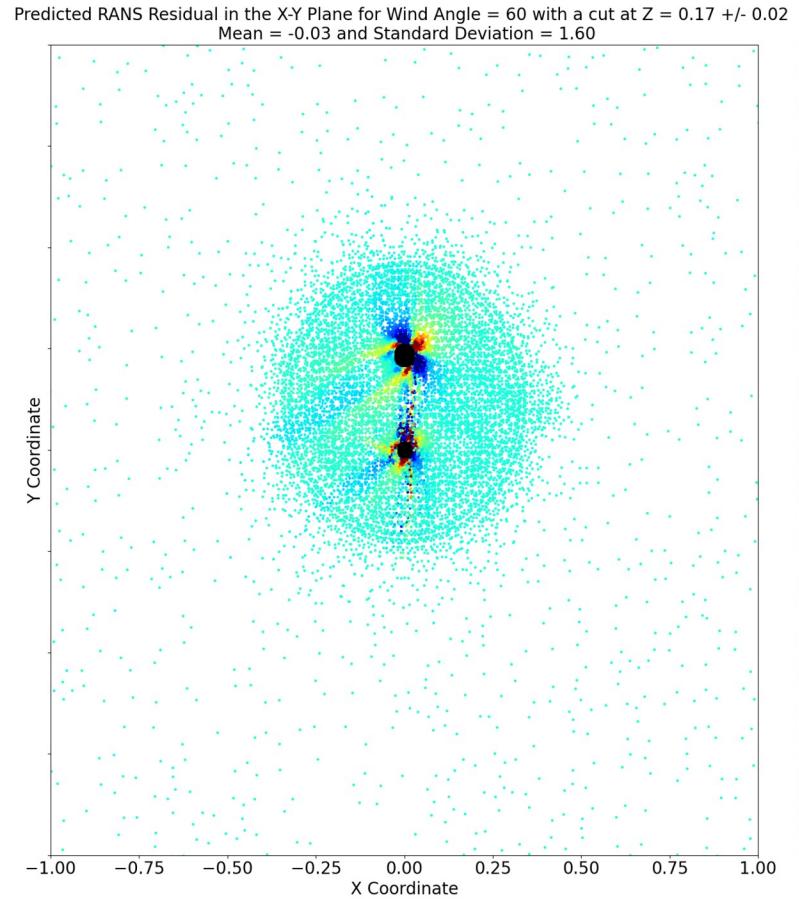
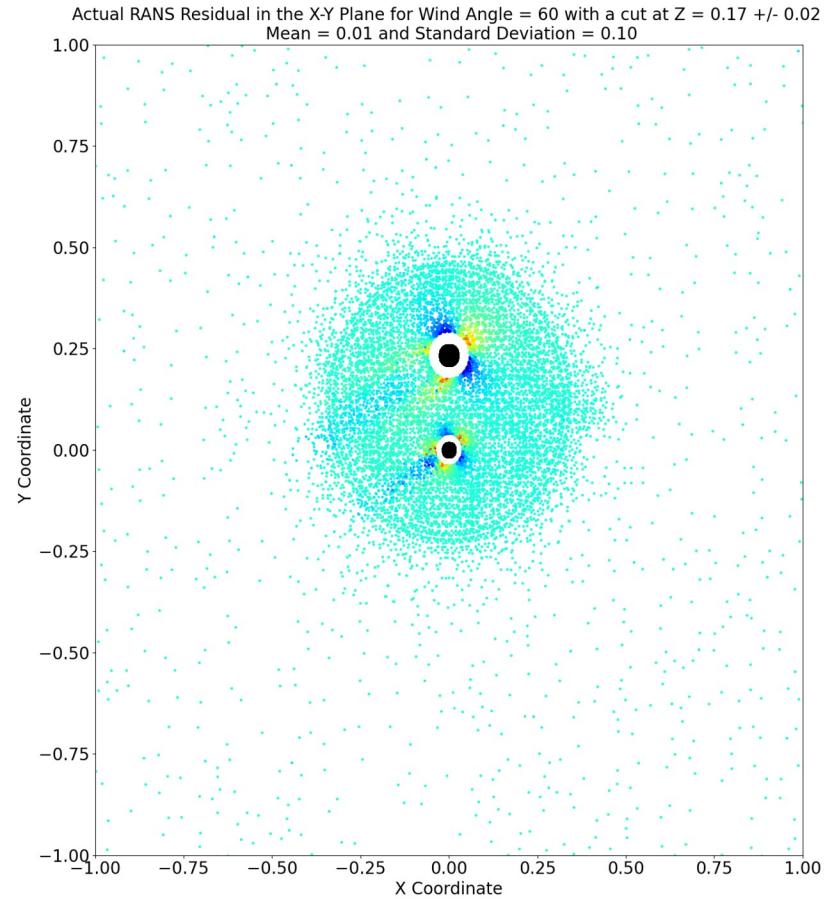
RANS Residual - Predicted

RANS Residual - Actual

Comparison of Actual vs. Predicted values with Wind Angle = 45 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



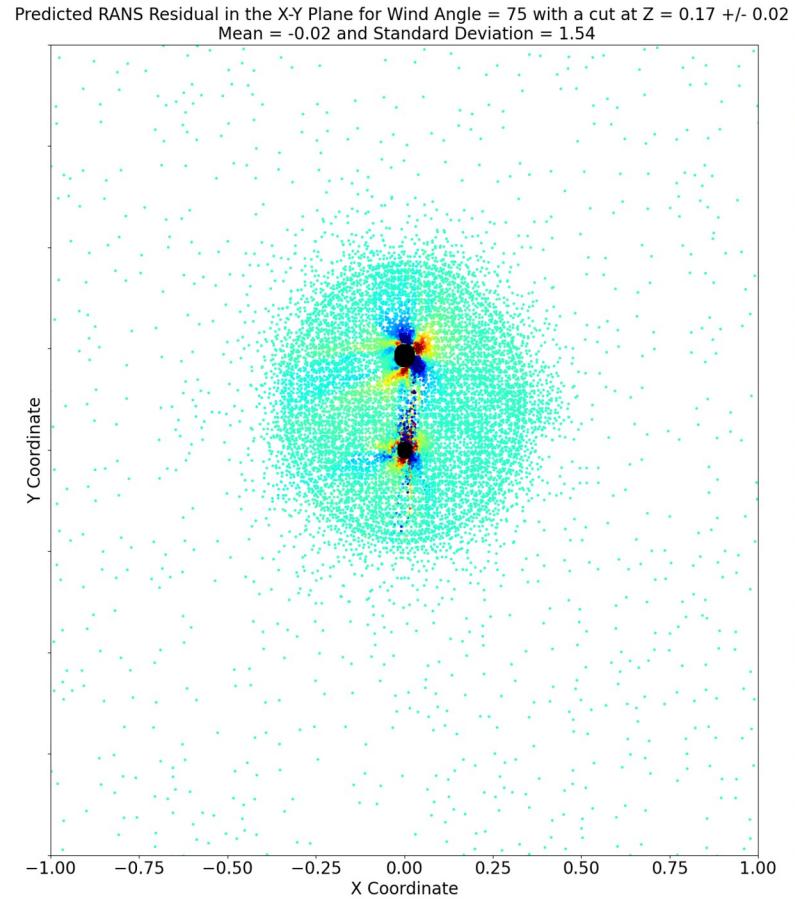
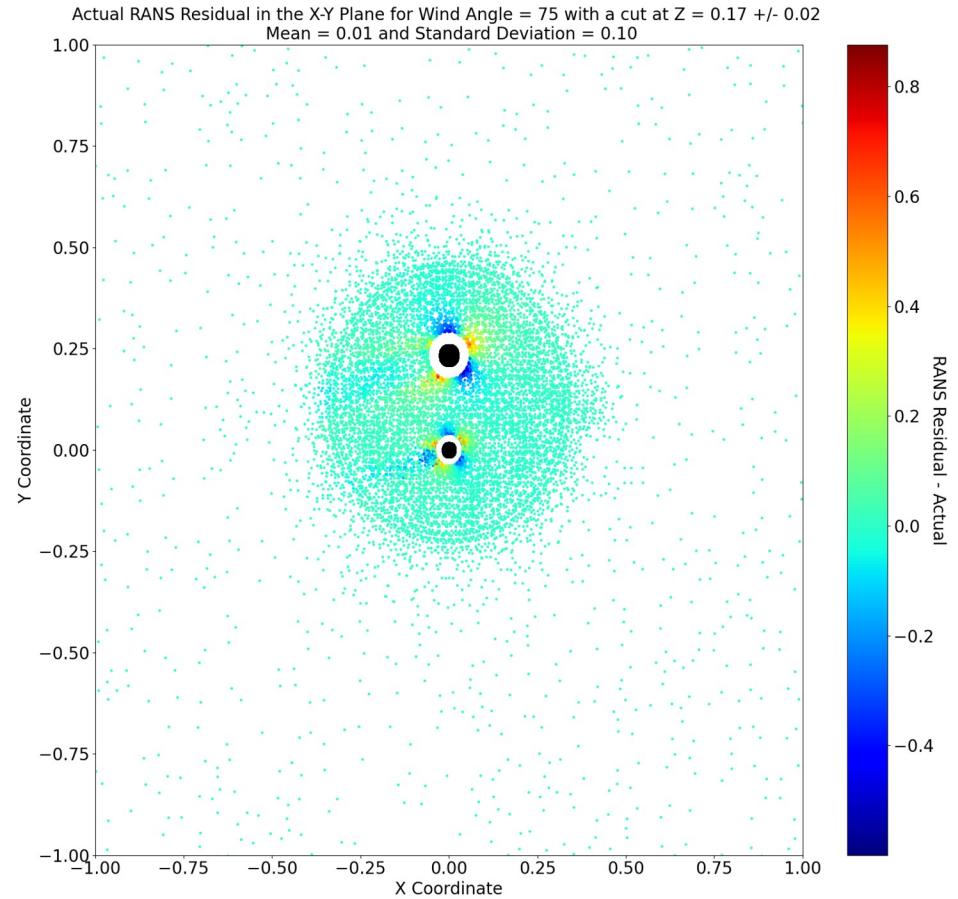
Comparison of Actual vs. Predicted values with Wind Angle = 60 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



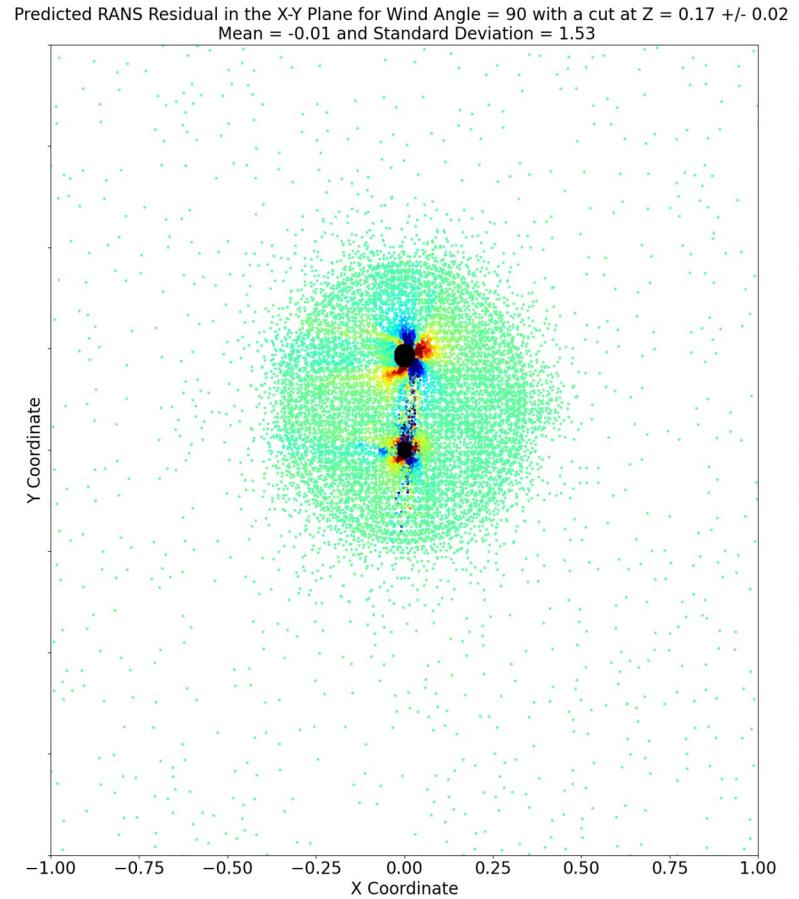
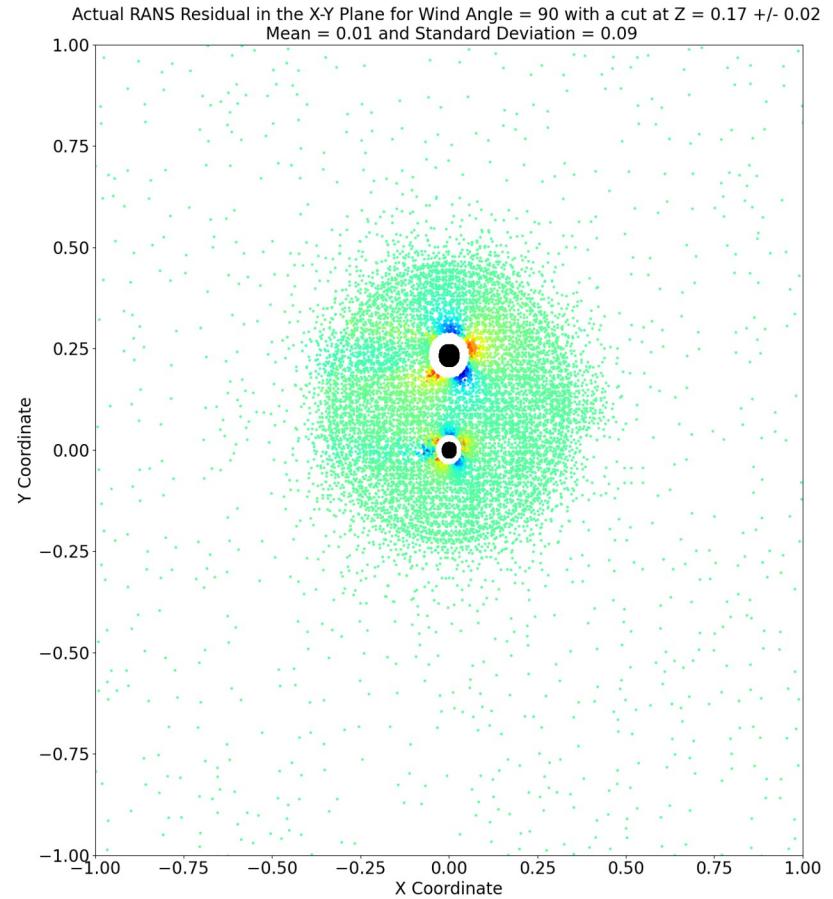
RANS Residual - Predicted

RANS Residual - Actual

Comparison of Actual vs. Predicted values with Wind Angle = 75 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



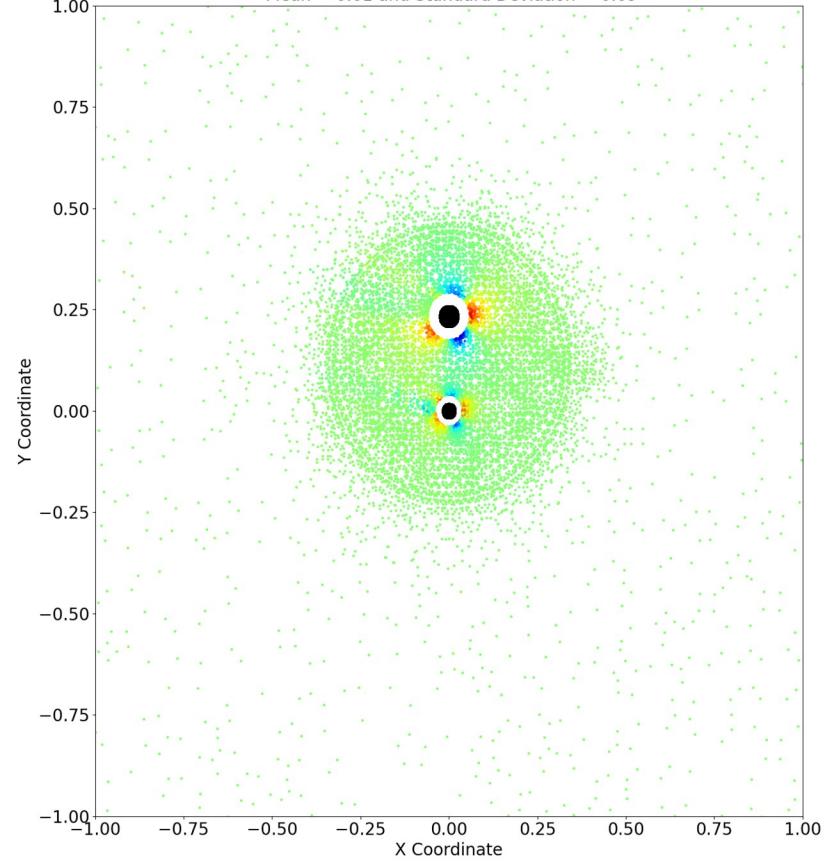
Comparison of Actual vs. Predicted values with Wind Angle = 90 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



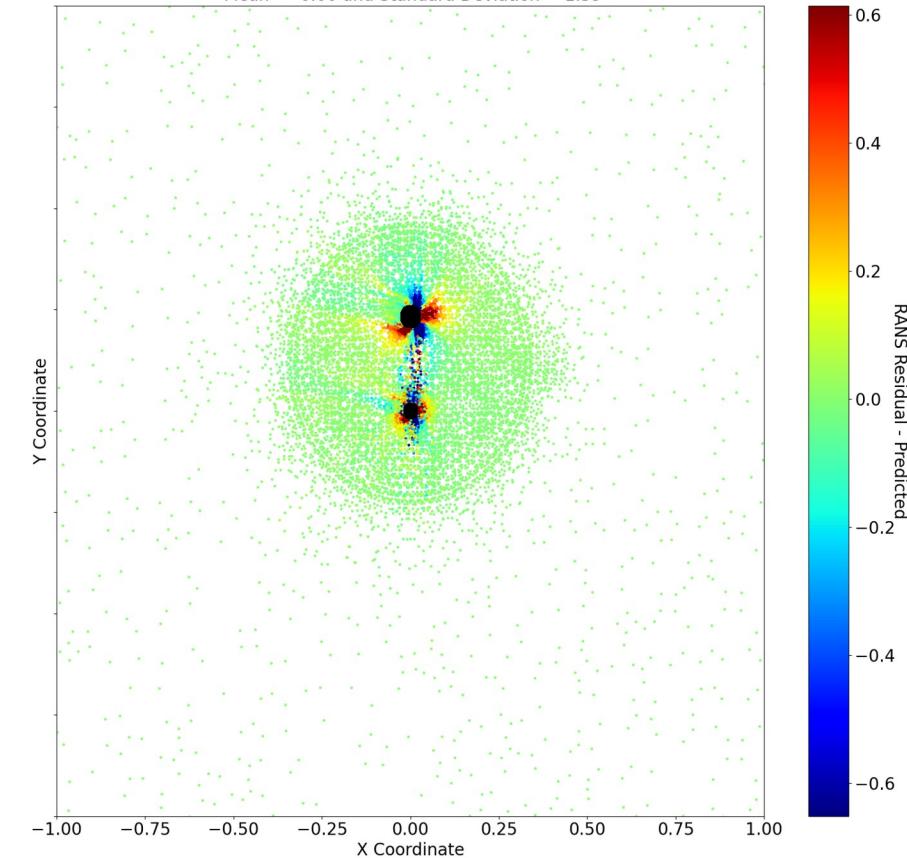
RANS Residual - Predicted

Comparison of Actual vs. Predicted values with Wind Angle = 105 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

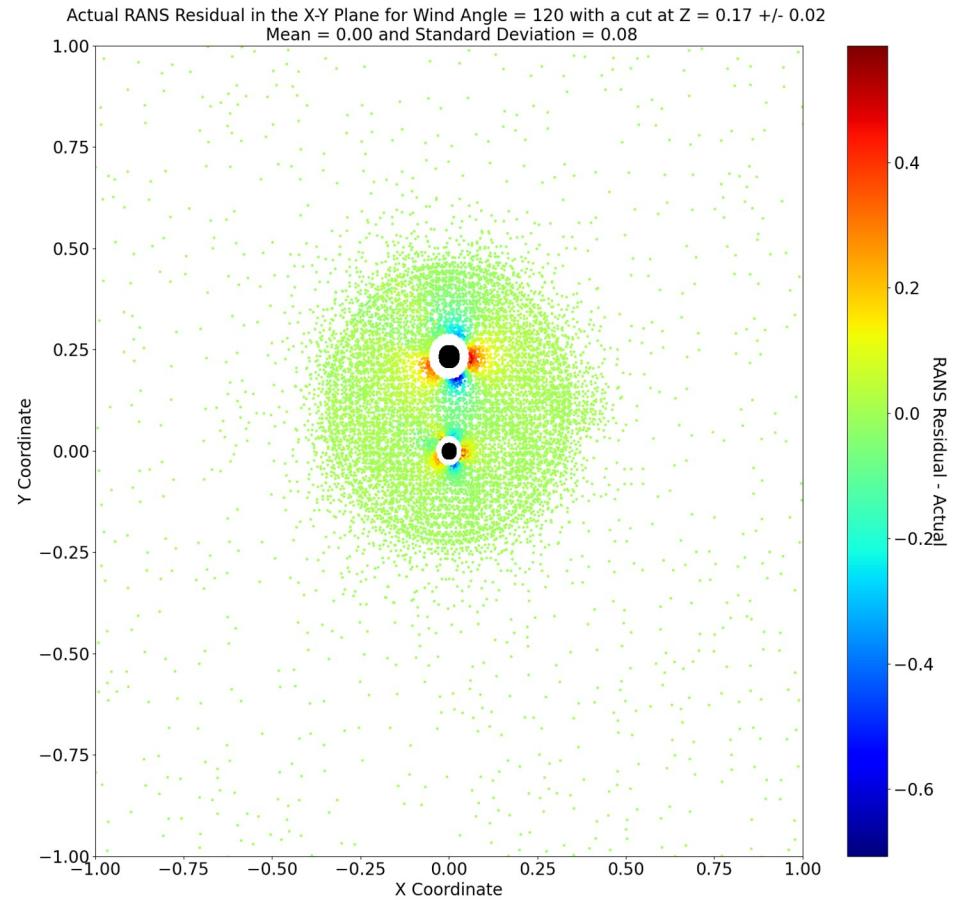
Actual RANS Residual in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02
Mean = 0.01 and Standard Deviation = 0.09



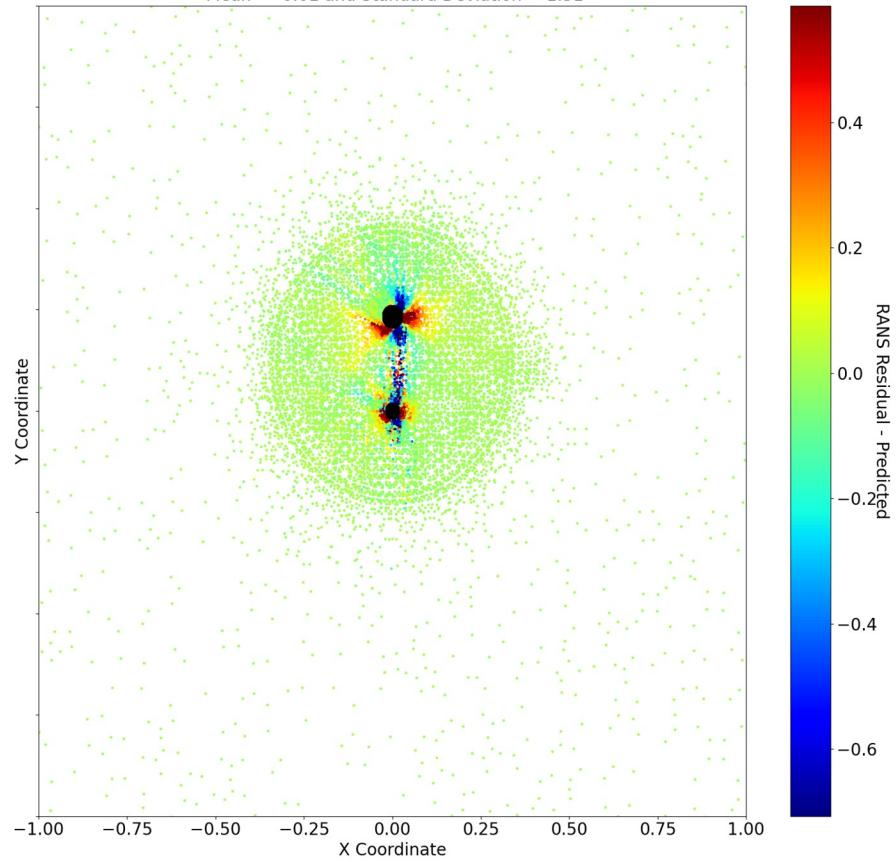
Predicted RANS Residual in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02
Mean = -0.00 and Standard Deviation = 1.39



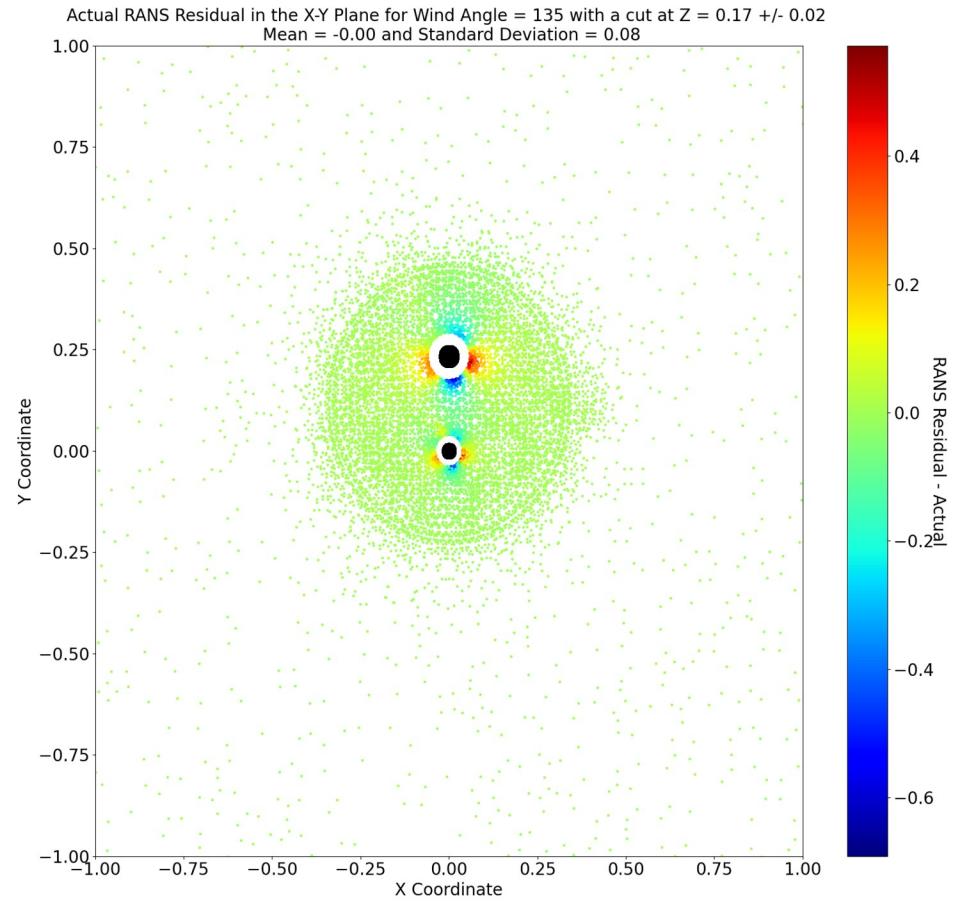
Comparison of Actual vs. Predicted values with Wind Angle = 120 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



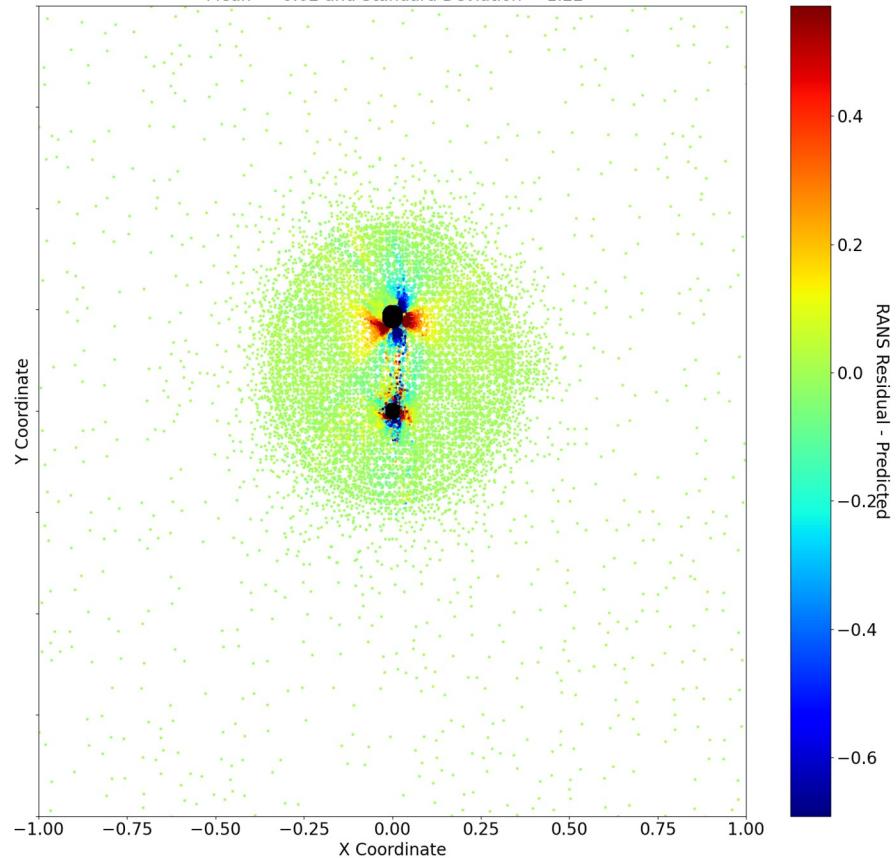
Predicted RANS Residual in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02
Mean = -0.01 and Standard Deviation = 1.31



Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

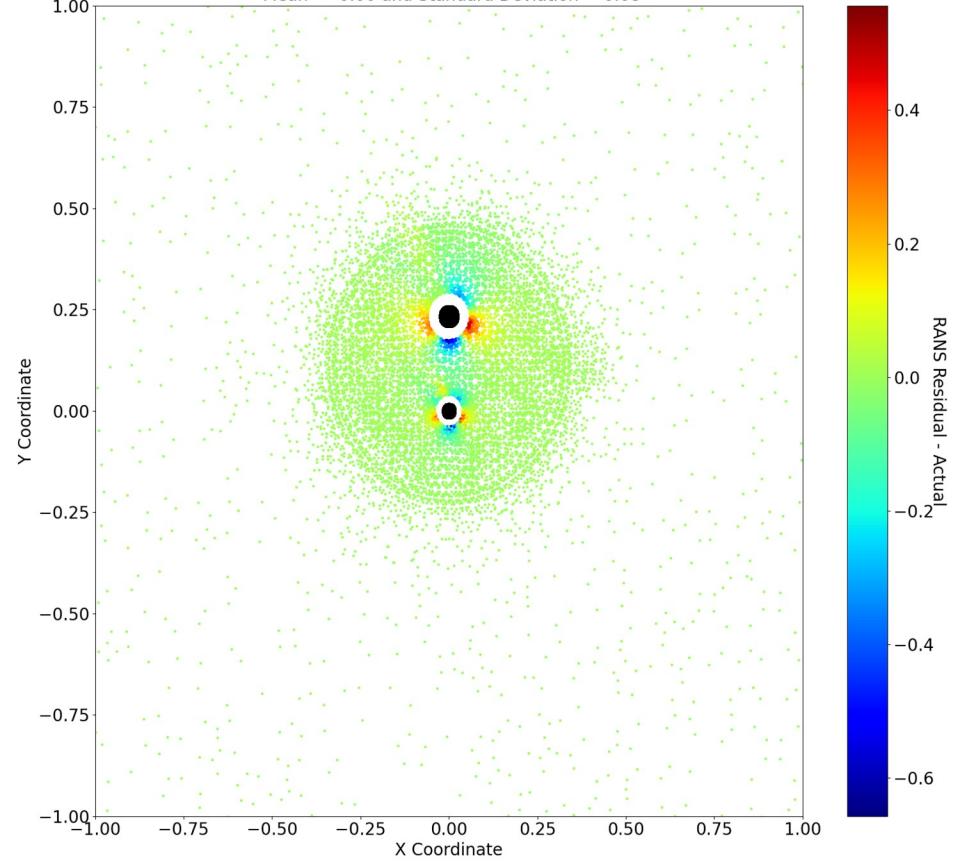


Predicted RANS Residual in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Mean = -0.02 and Standard Deviation = 1.22

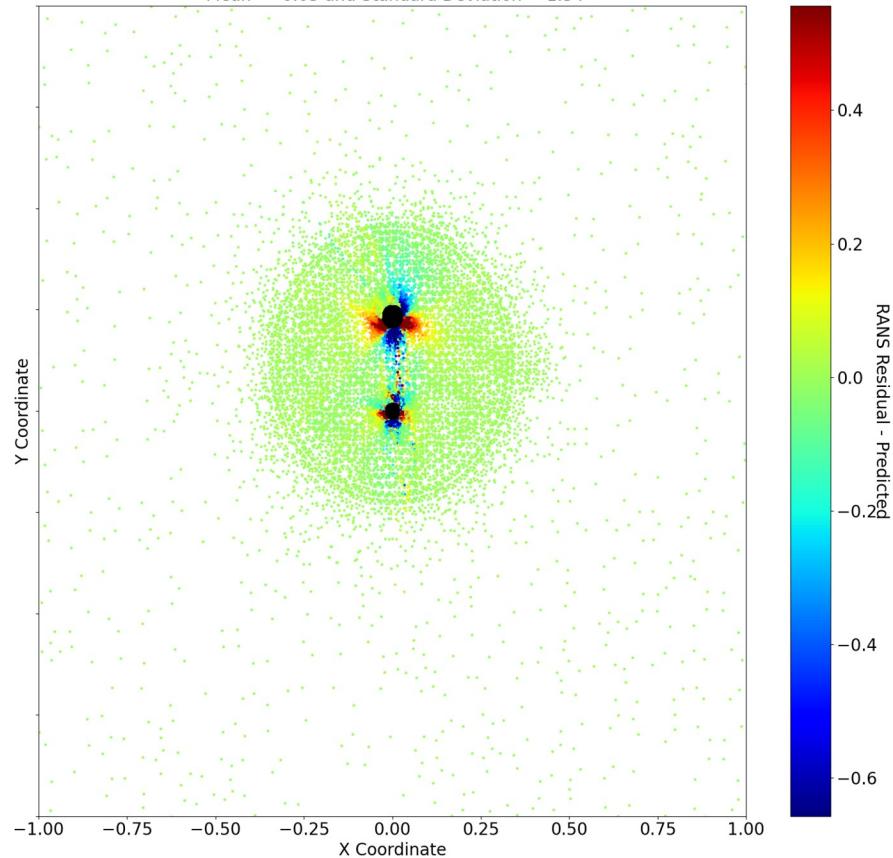


Comparison of Actual vs. Predicted values with Wind Angle = 150 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

Actual RANS Residual in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02
Mean = -0.00 and Standard Deviation = 0.08

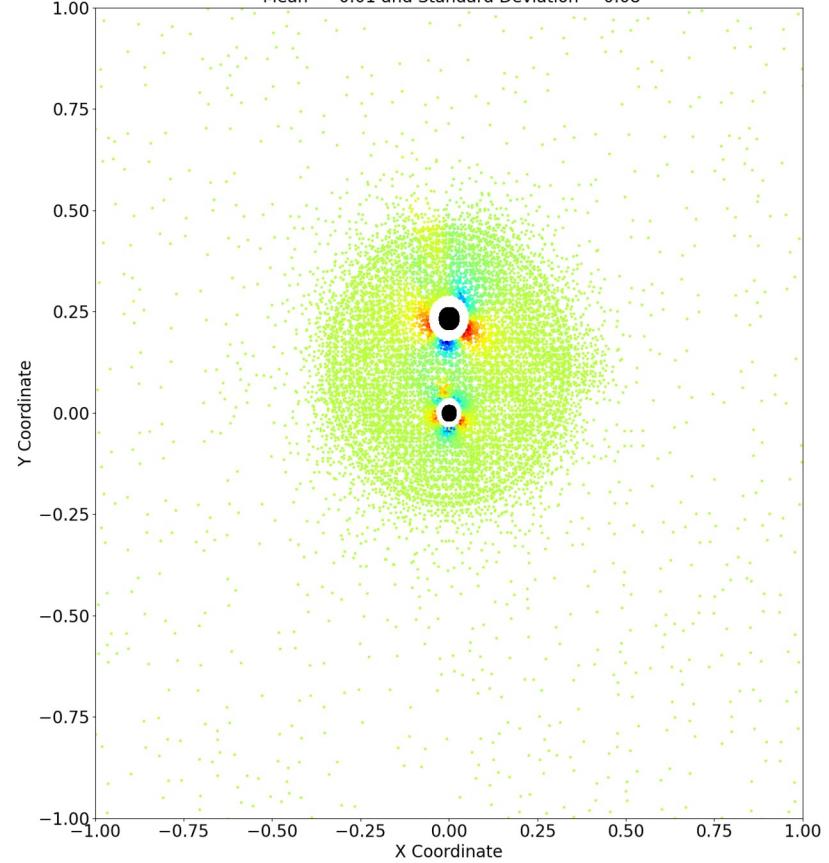


Predicted RANS Residual in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02
Mean = -0.03 and Standard Deviation = 1.34

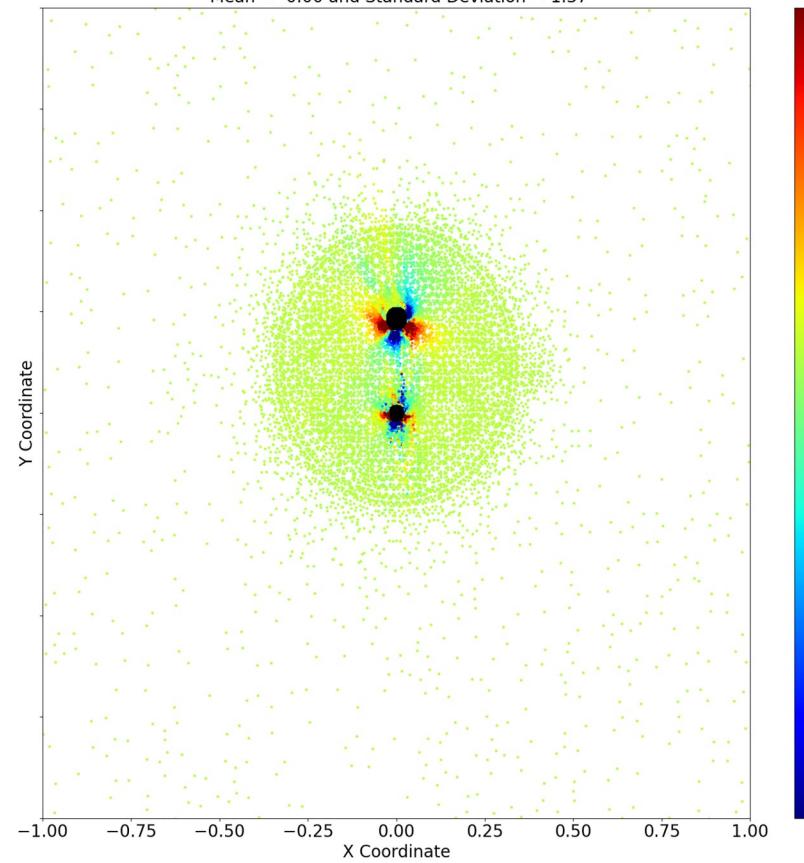


Comparison of Actual vs. Predicted values with Wind Angle = 165 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

Actual RANS Residual in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02
Mean = -0.01 and Standard Deviation = 0.08

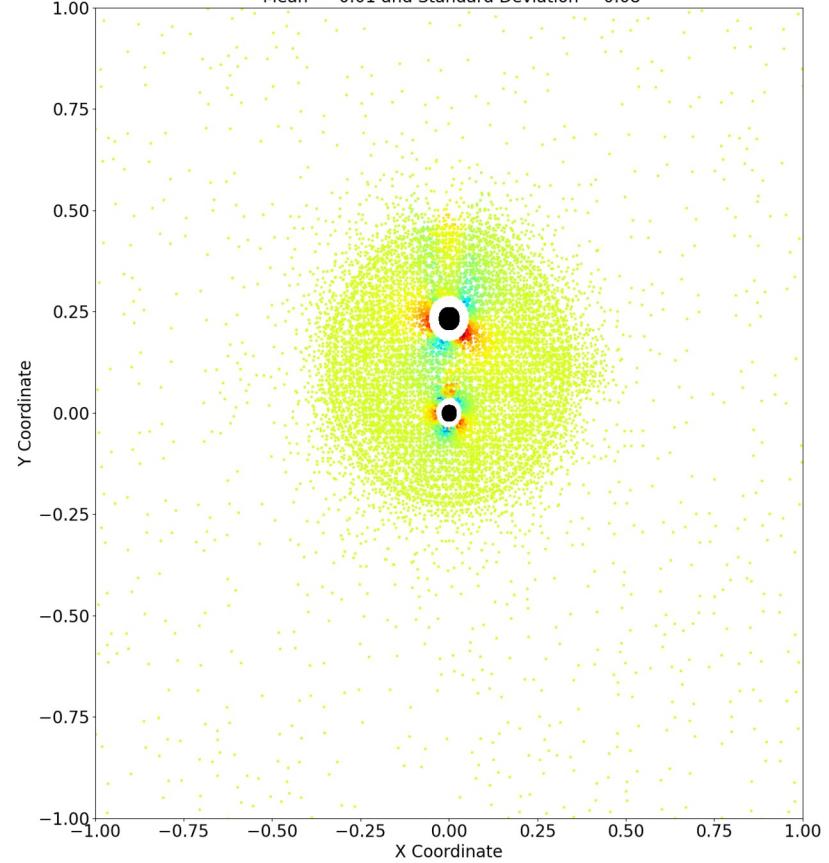


Predicted RANS Residual in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02
Mean = -0.00 and Standard Deviation = 1.37

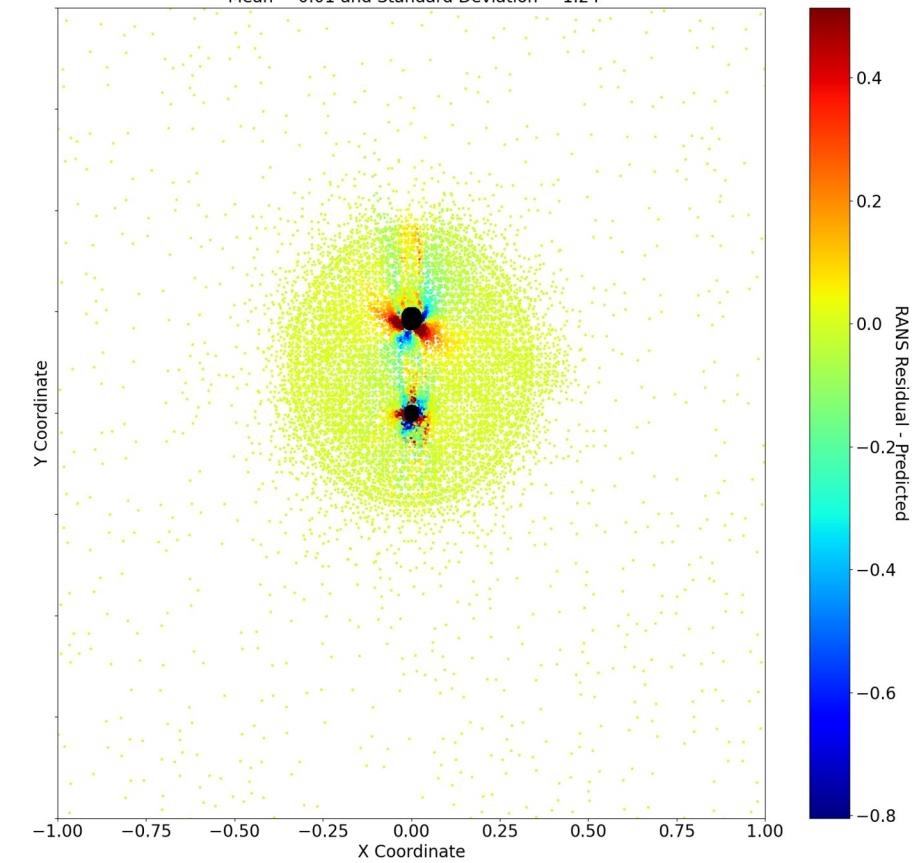


Comparison of Actual vs. Predicted values with Wind Angle = 180 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

Actual RANS Residual in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02
Mean = -0.01 and Standard Deviation = 0.08



Predicted RANS Residual in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02
Mean = 0.01 and Standard Deviation = 1.24



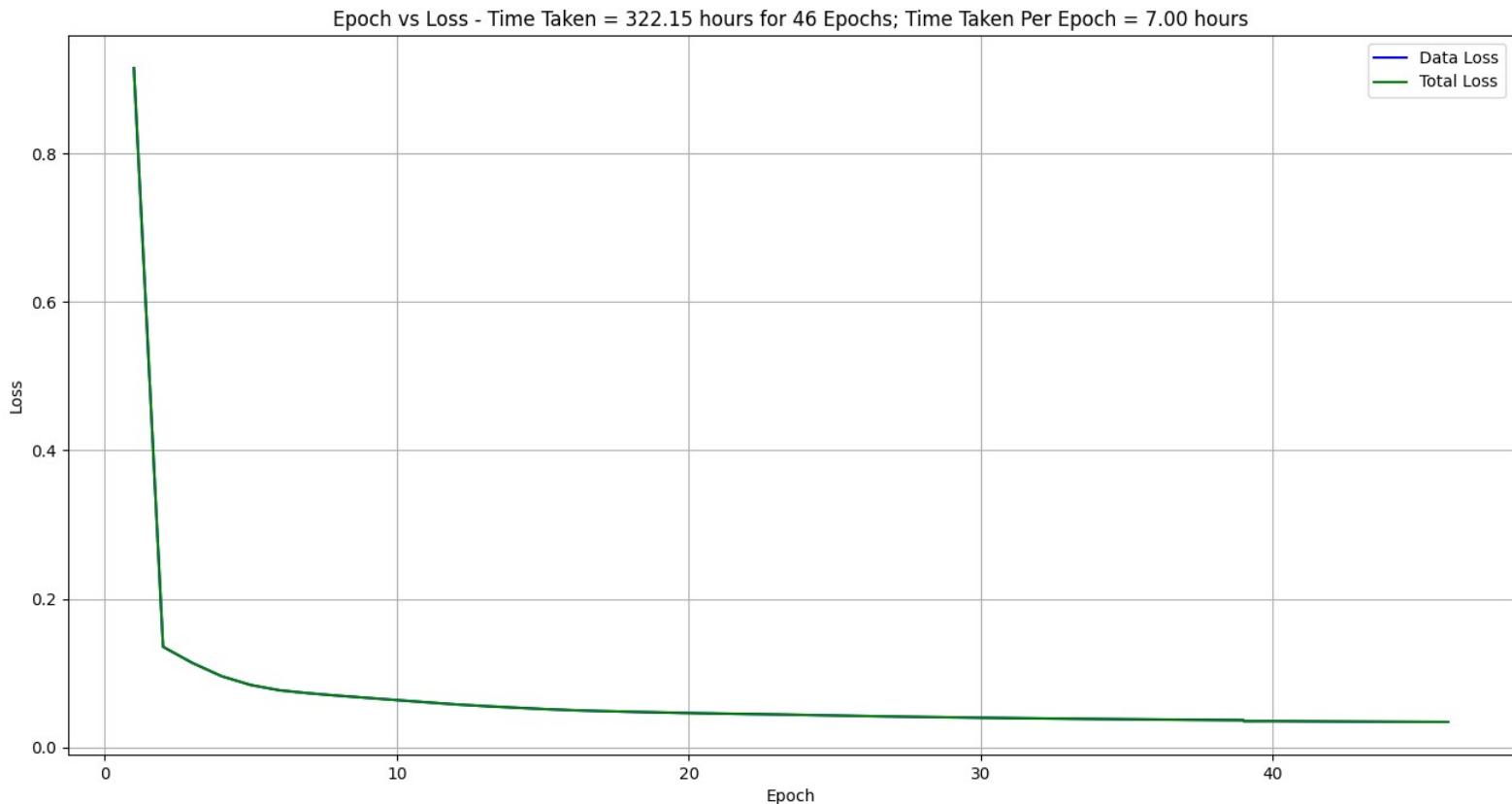
LA DEFENSE

Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

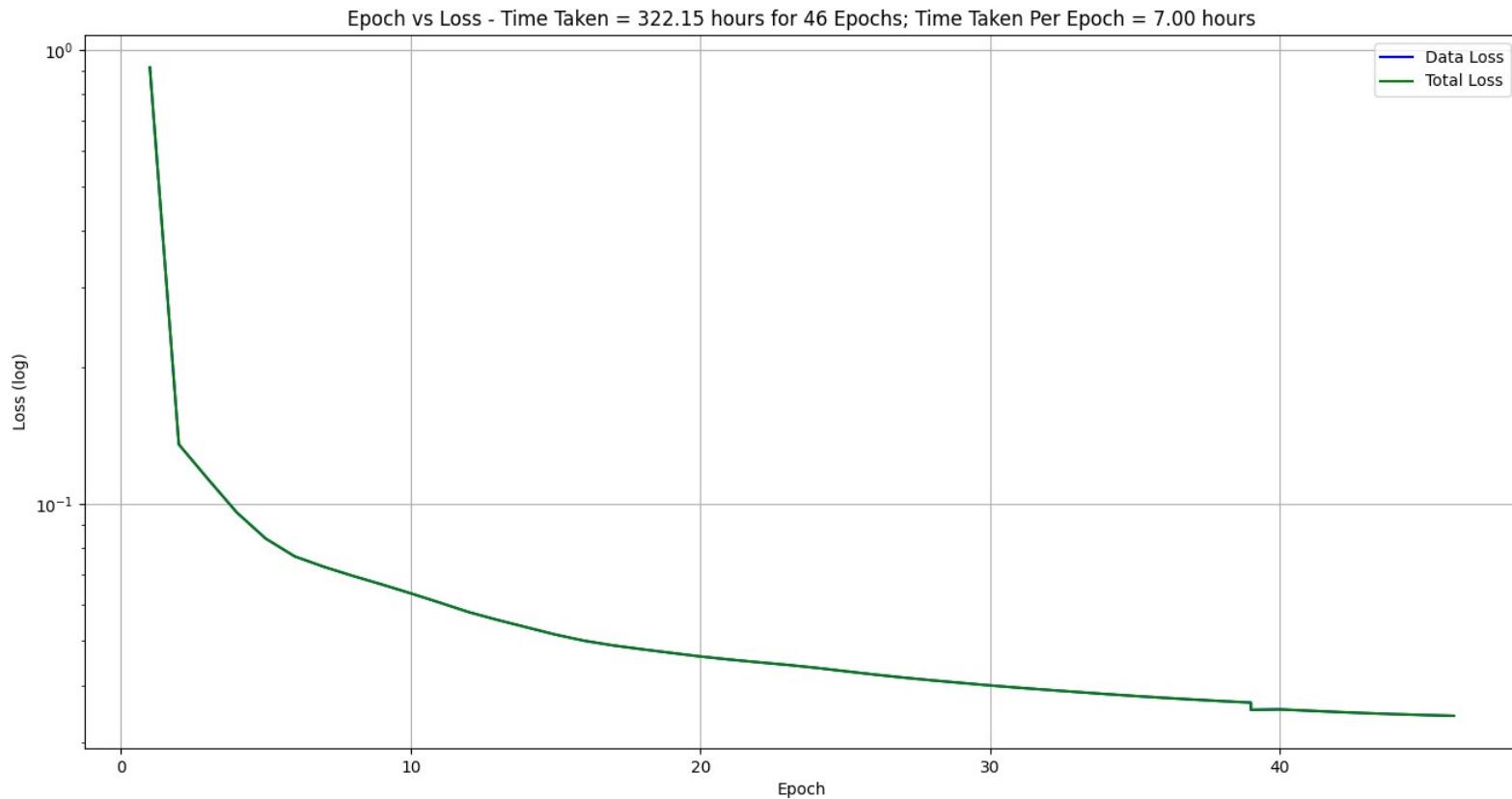
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Workstation

Scripts v5 – TESTING

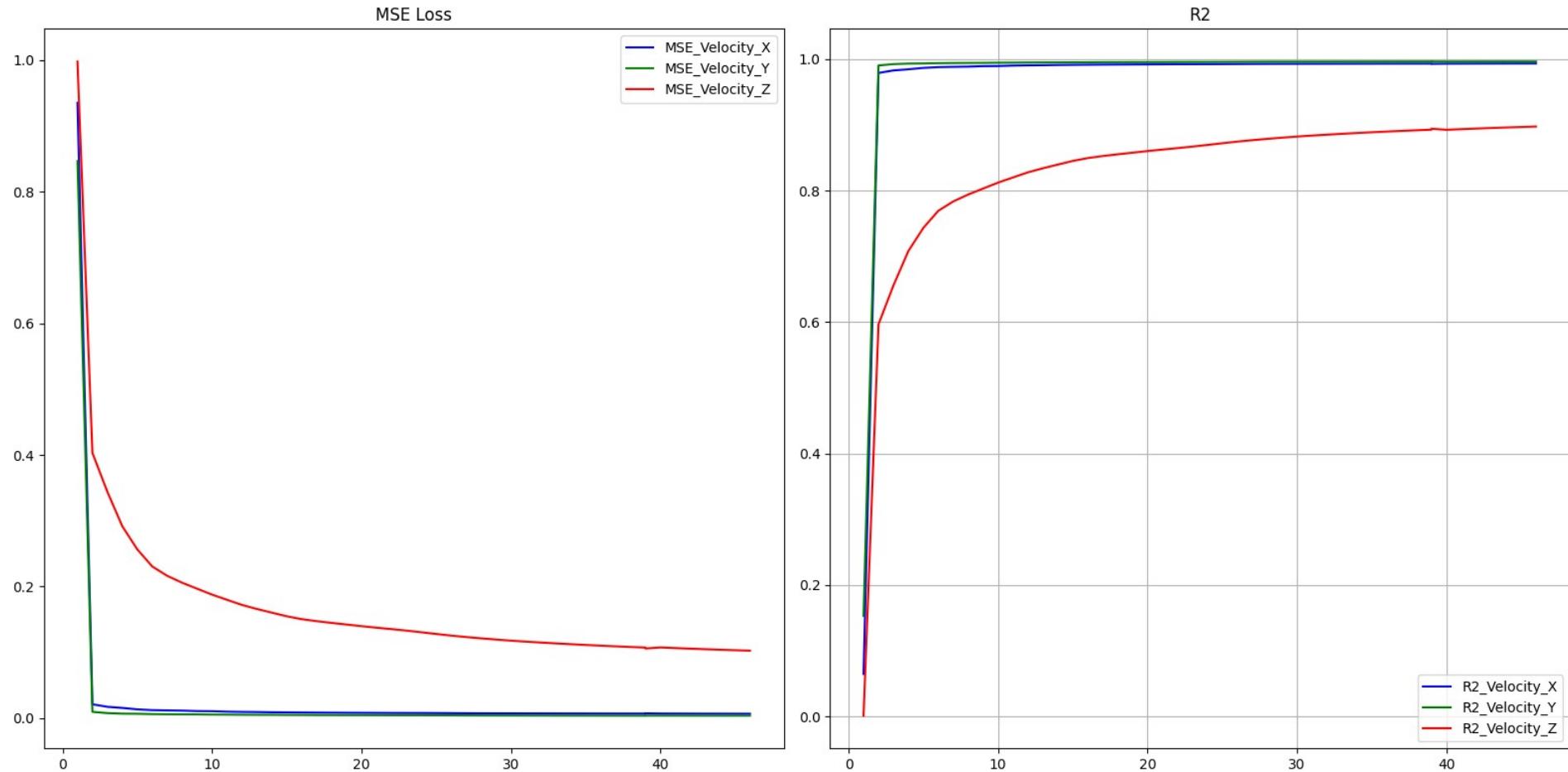
Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop
Logging Plots (Training)



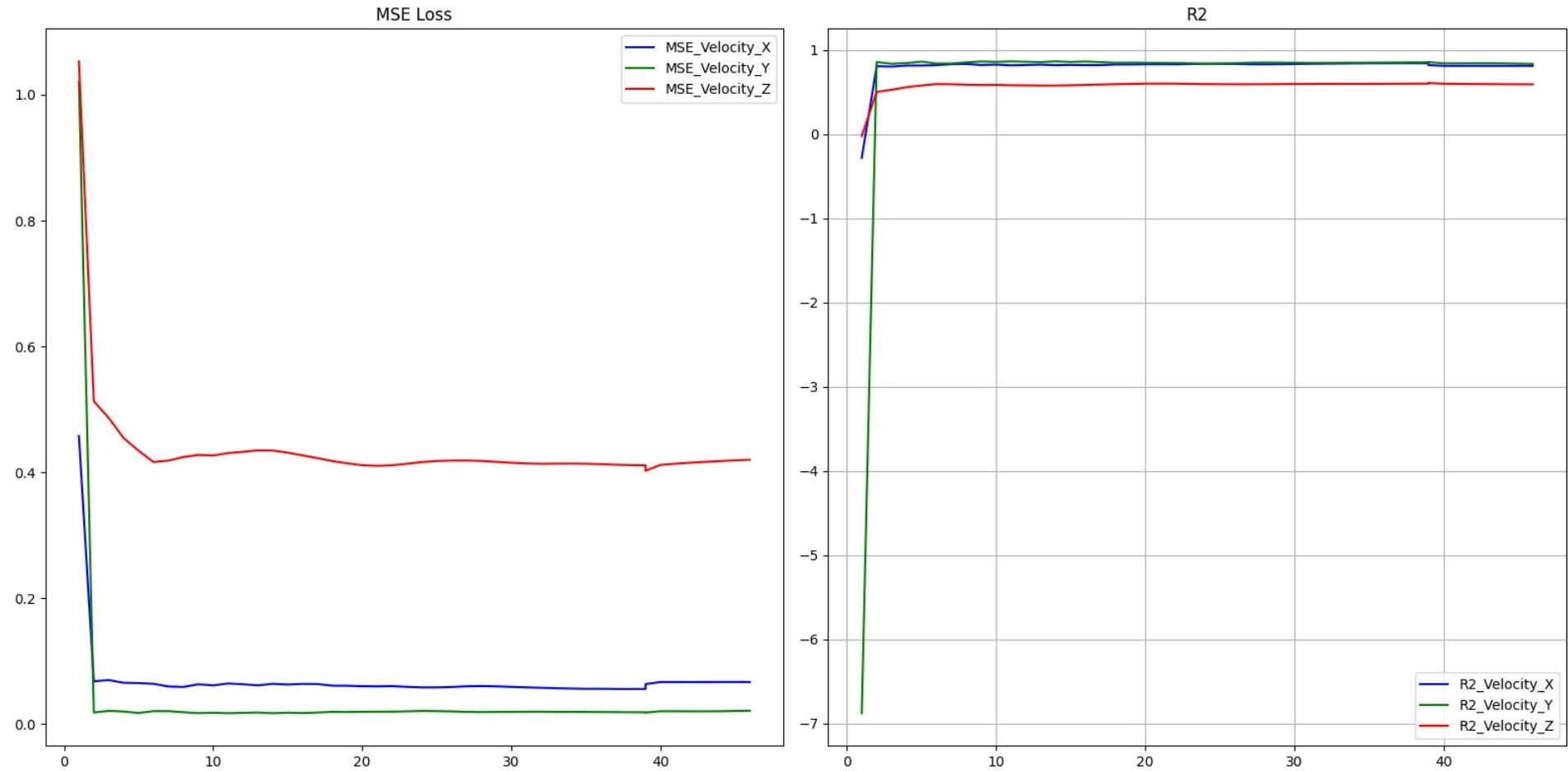
Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop
Logging Plots (Training)



Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop
Logging Plots (Testing)

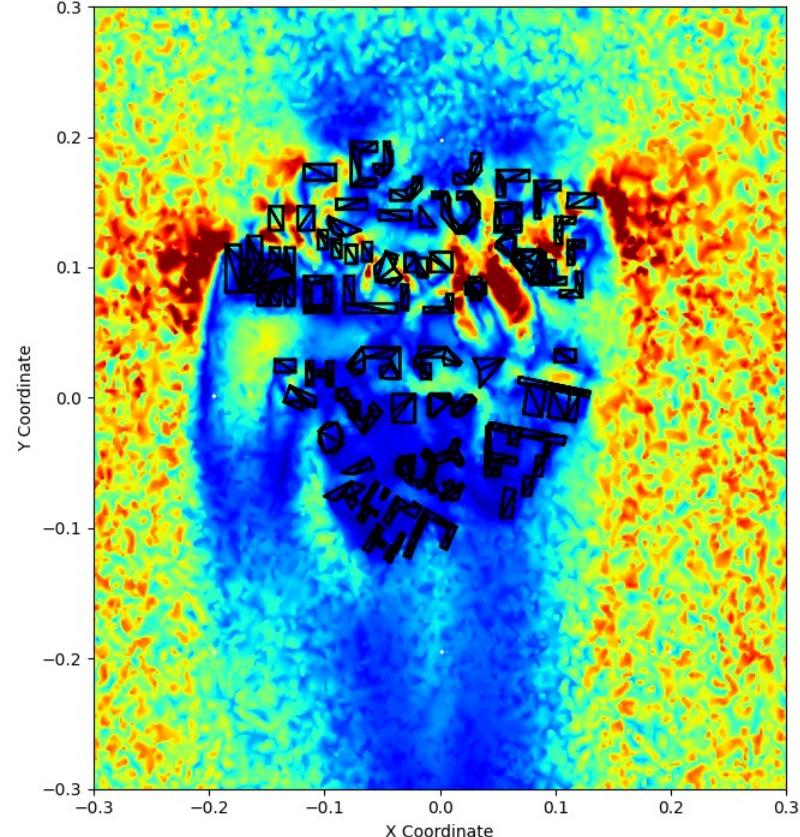


Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop
Logging Plots (Predicting 135)

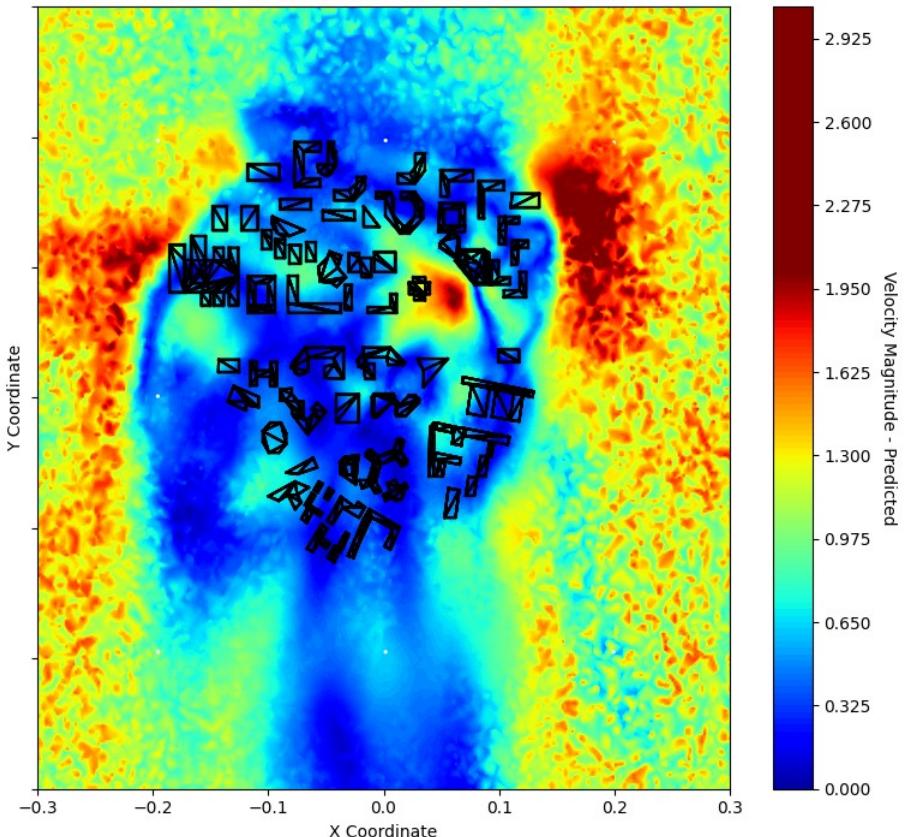


Comparison of Actual vs. Predicted values with Wind Angle = 0 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.01 +/- 0.01
Mean = 0.98 and Standard Deviation = 0.52

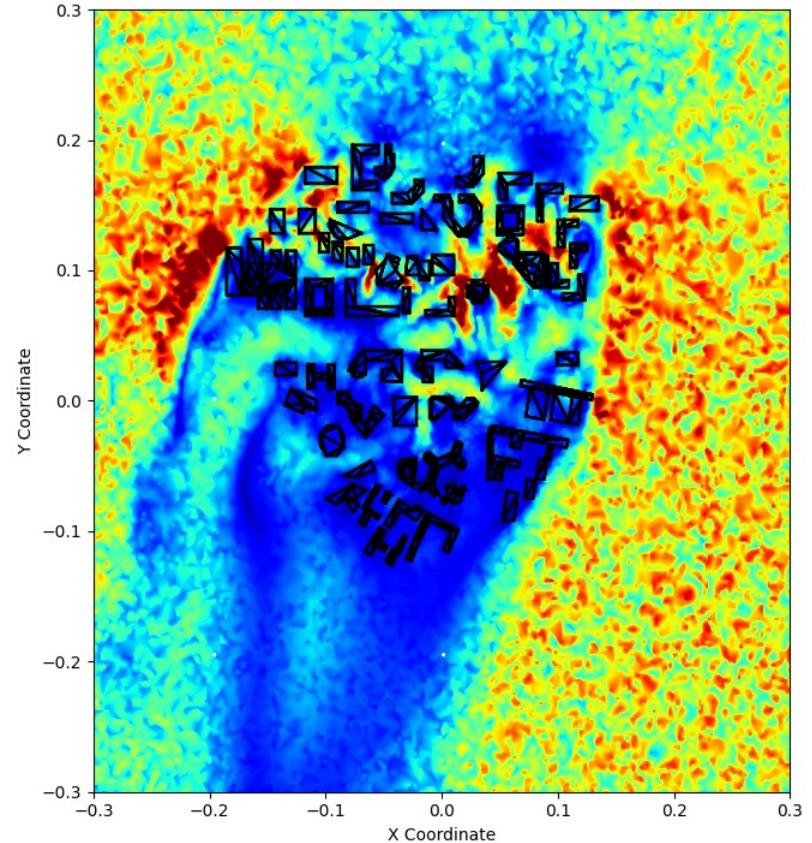


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.01 +/- 0.01
Mean = 1.05 and Standard Deviation = 0.49

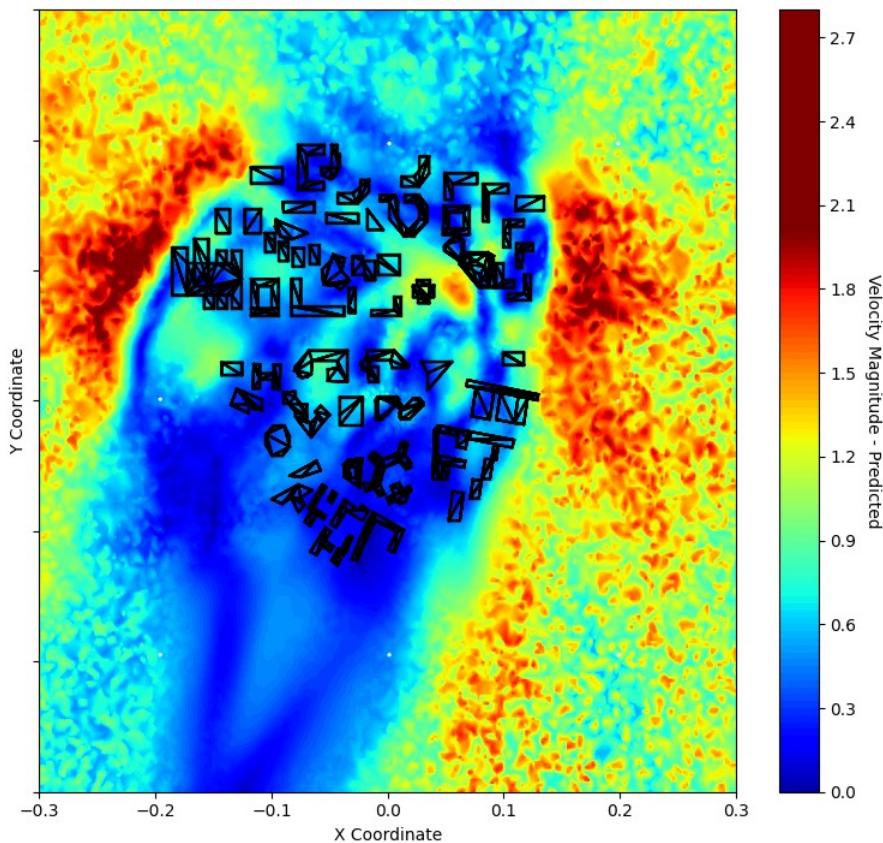


Comparison of Actual vs. Predicted values with Wind Angle = 15 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.01 +/- 0.01
Mean = 0.97 and Standard Deviation = 0.52

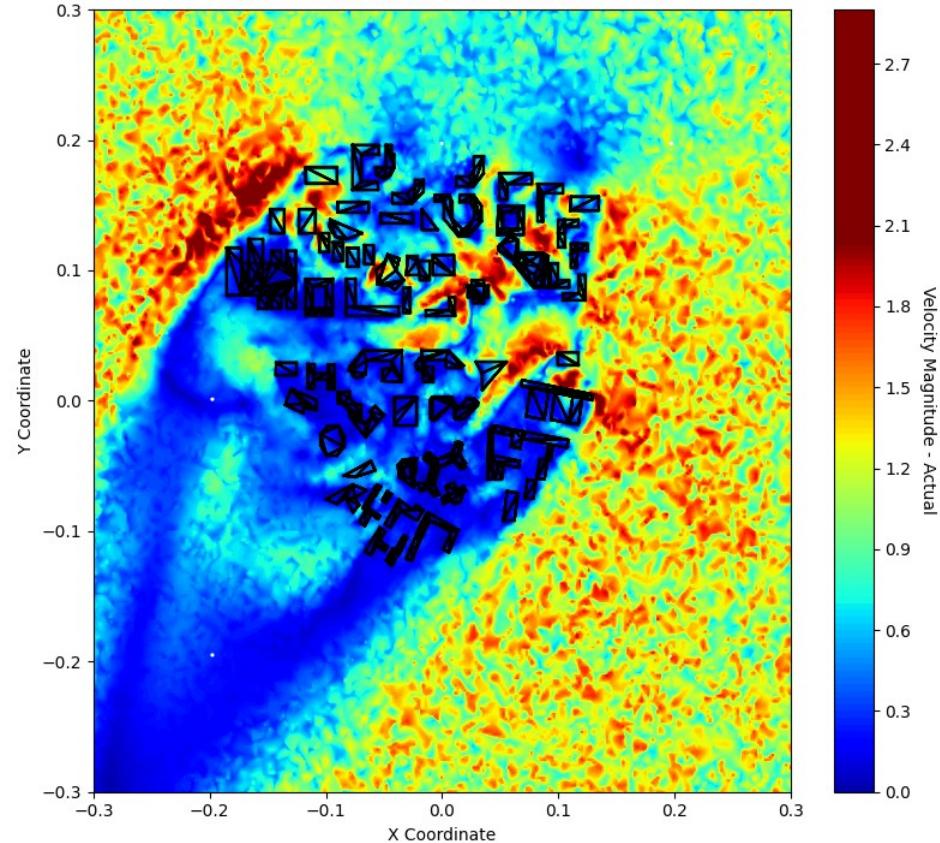


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.01 +/- 0.01
Mean = 1.00 and Standard Deviation = 0.48

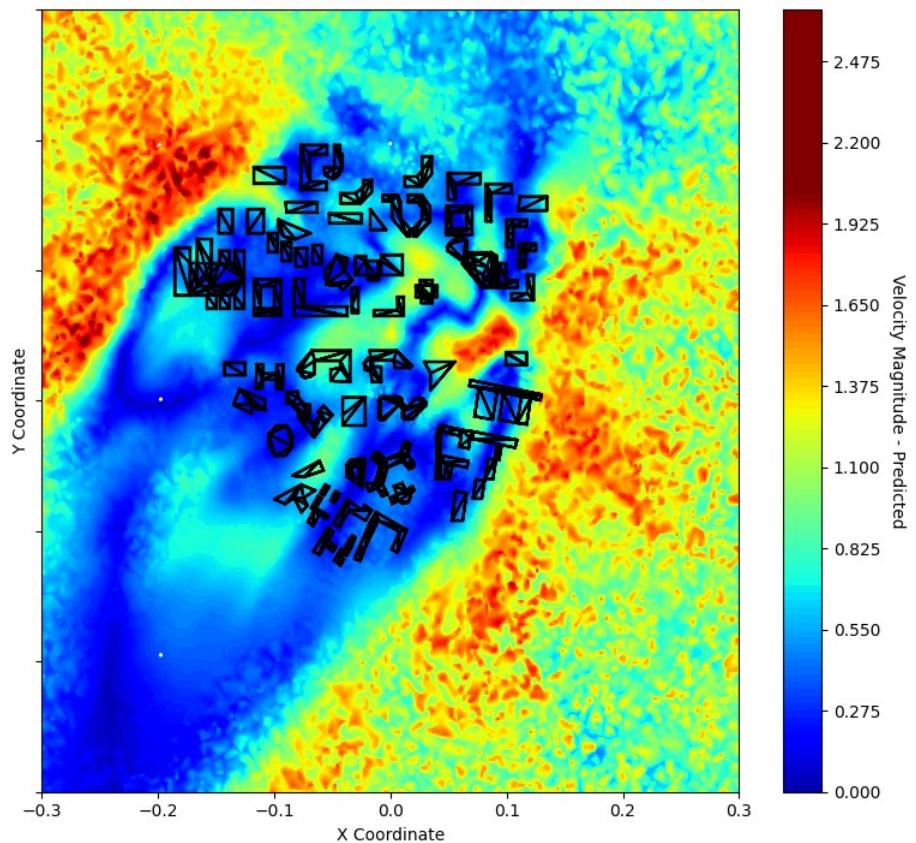


Comparison of Actual vs. Predicted values with Wind Angle = 30 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.01 +/- 0.01
Mean = 0.99 and Standard Deviation = 0.53

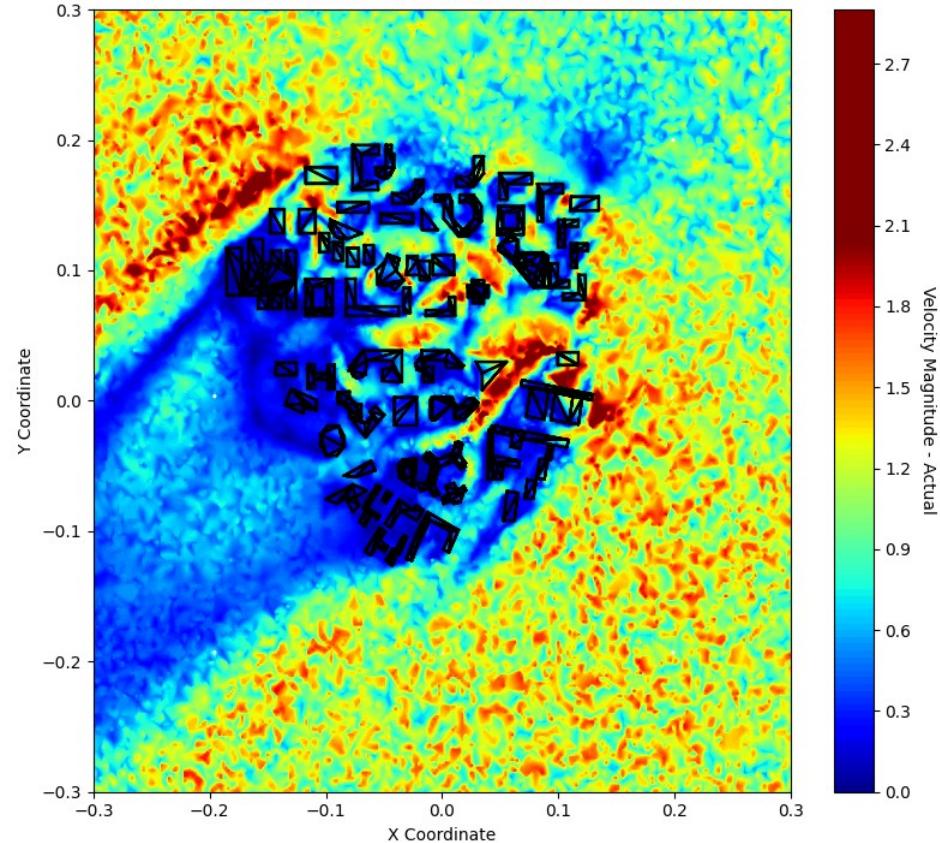


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.01 +/- 0.01
Mean = 0.99 and Standard Deviation = 0.48

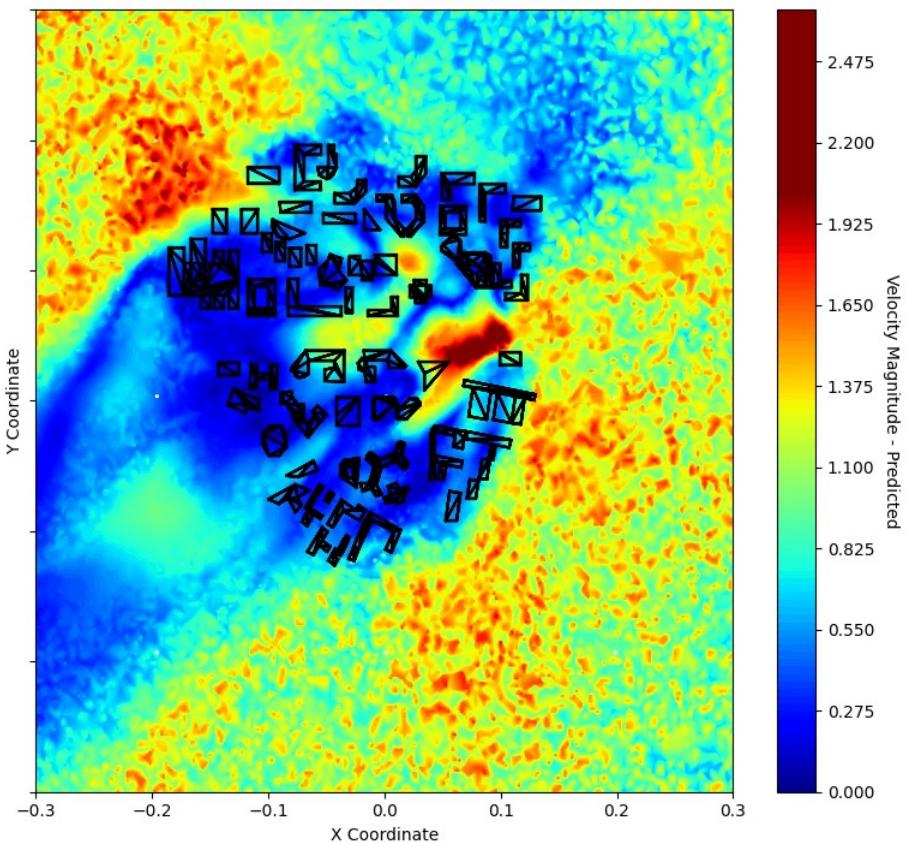


Comparison of Actual vs. Predicted values with Wind Angle = 45 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.51

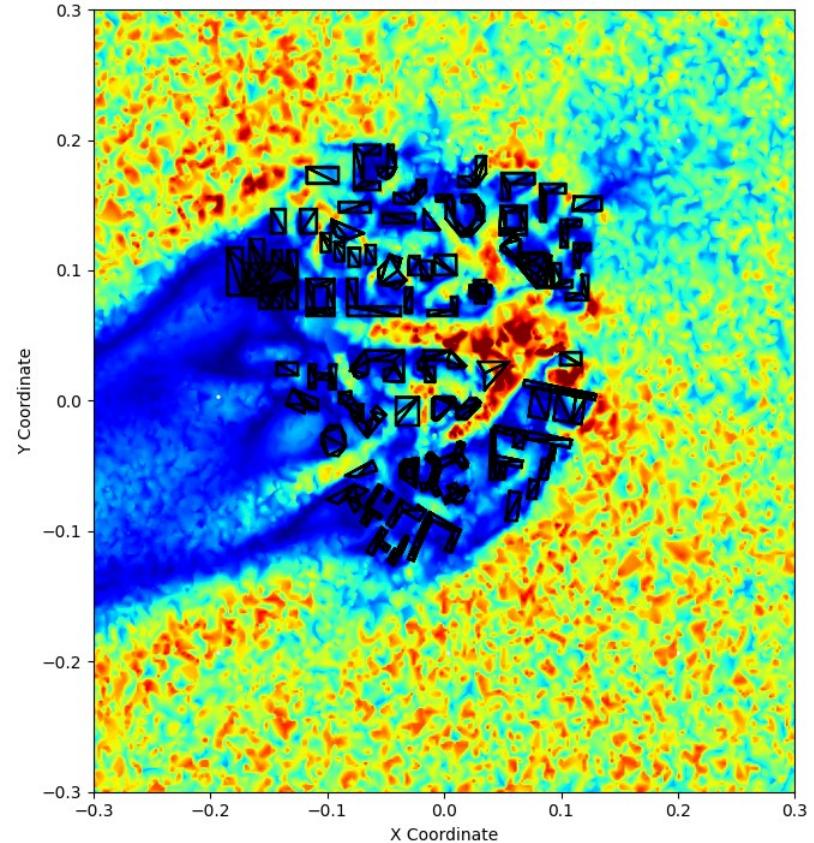


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.46

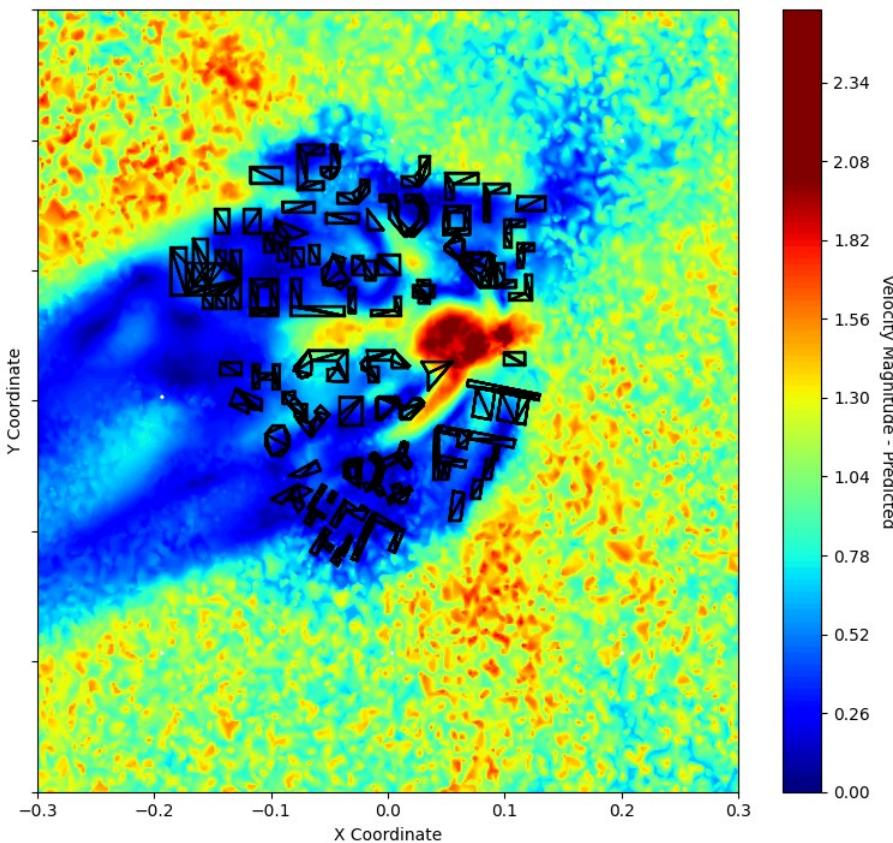


Comparison of Actual vs. Predicted values with Wind Angle = 60 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.50

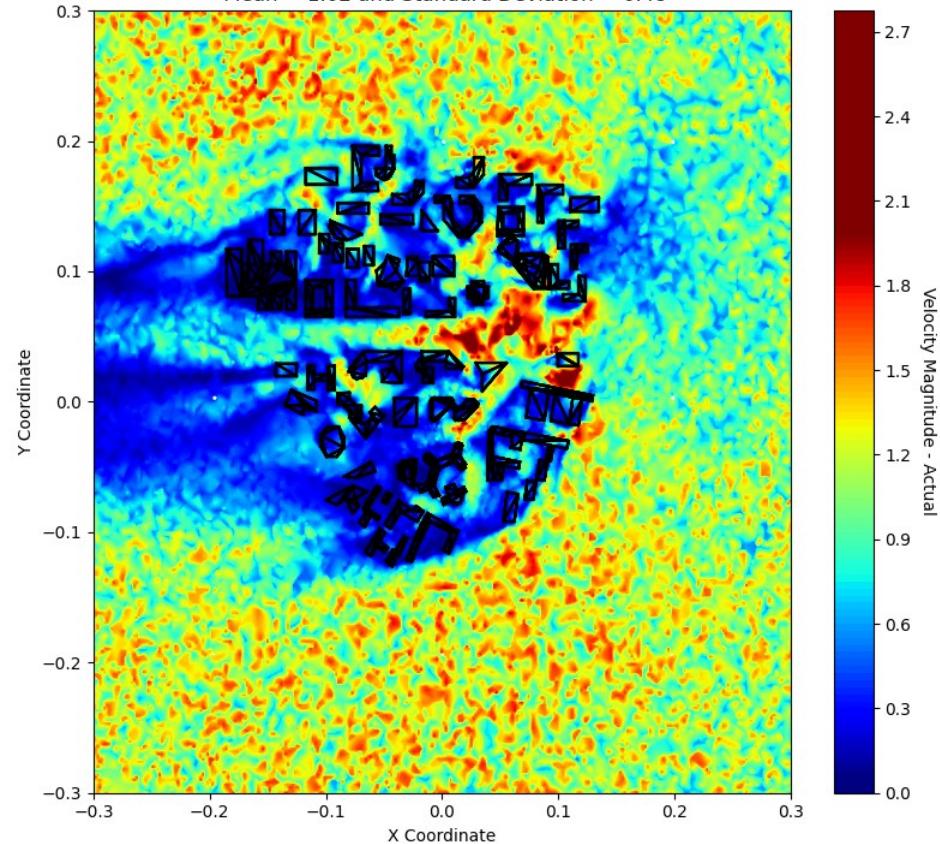


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.44

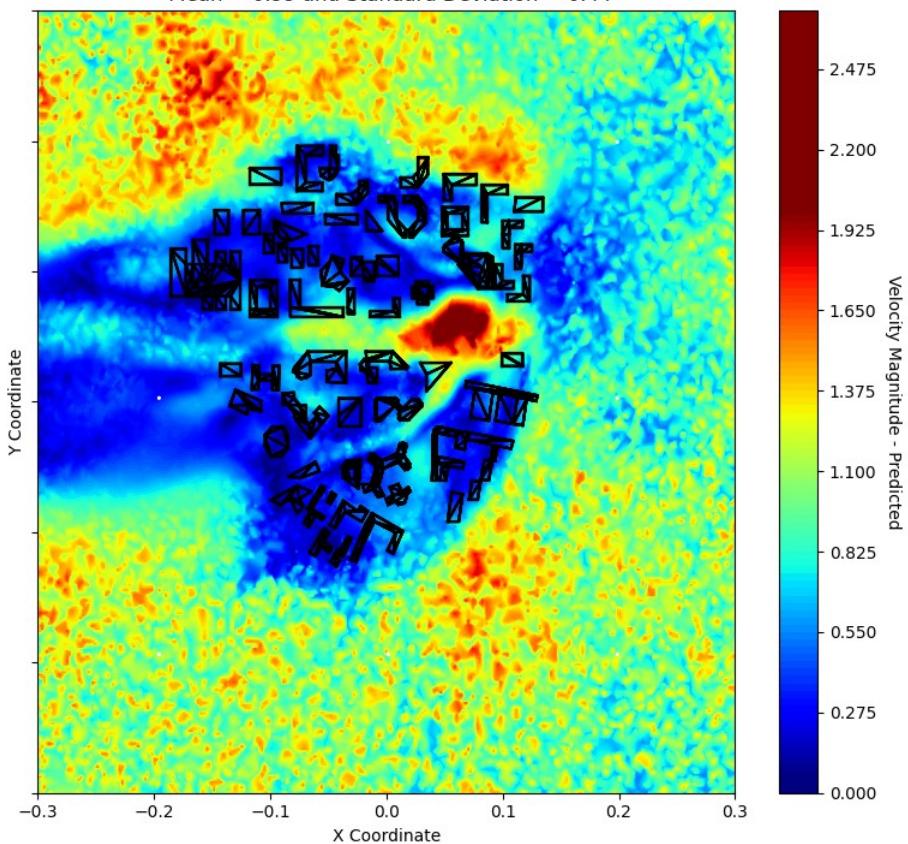


Comparison of Actual vs. Predicted values with Wind Angle = 75 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.48

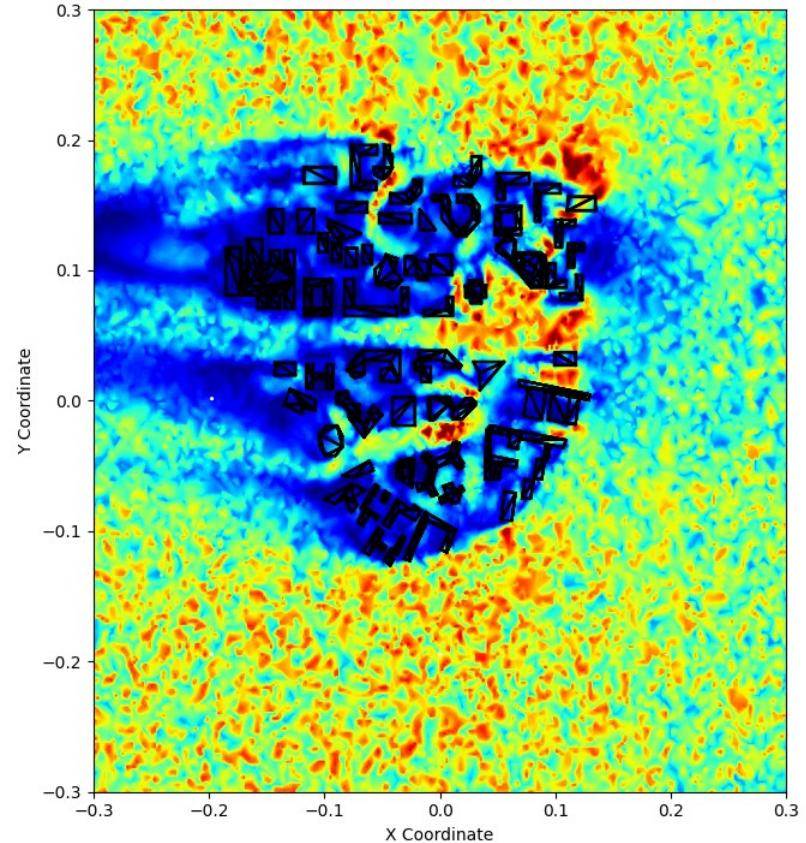


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.01 +/- 0.01
Mean = 0.99 and Standard Deviation = 0.44

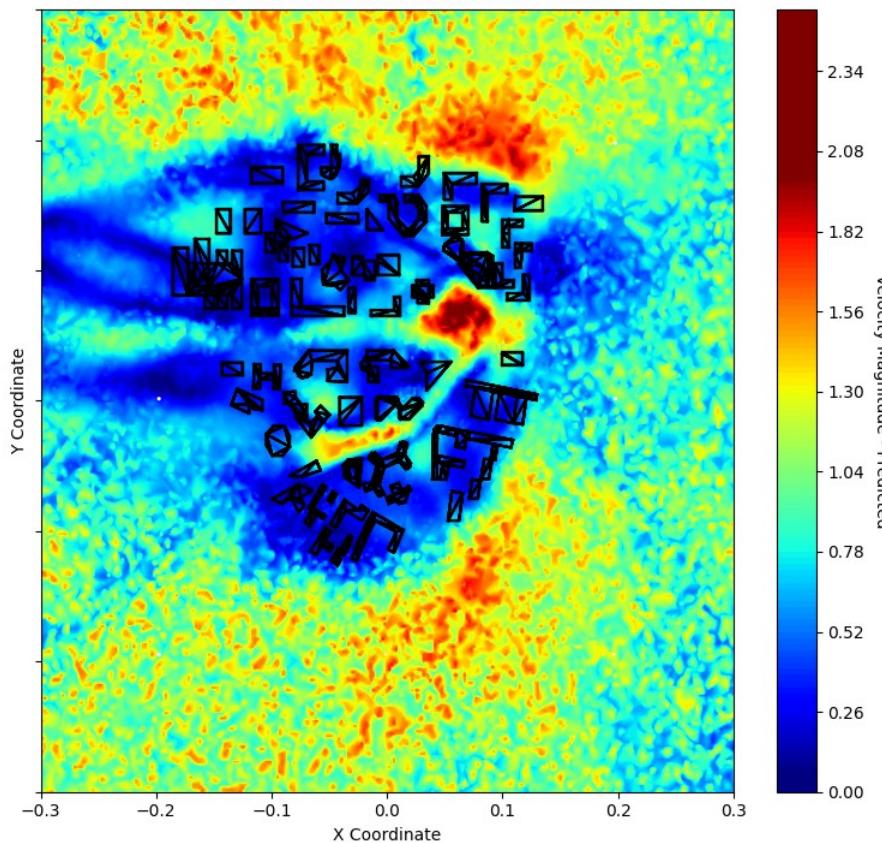


Comparison of Actual vs. Predicted values with Wind Angle = 90 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.01 +/- 0.01
Mean = 1.03 and Standard Deviation = 0.49

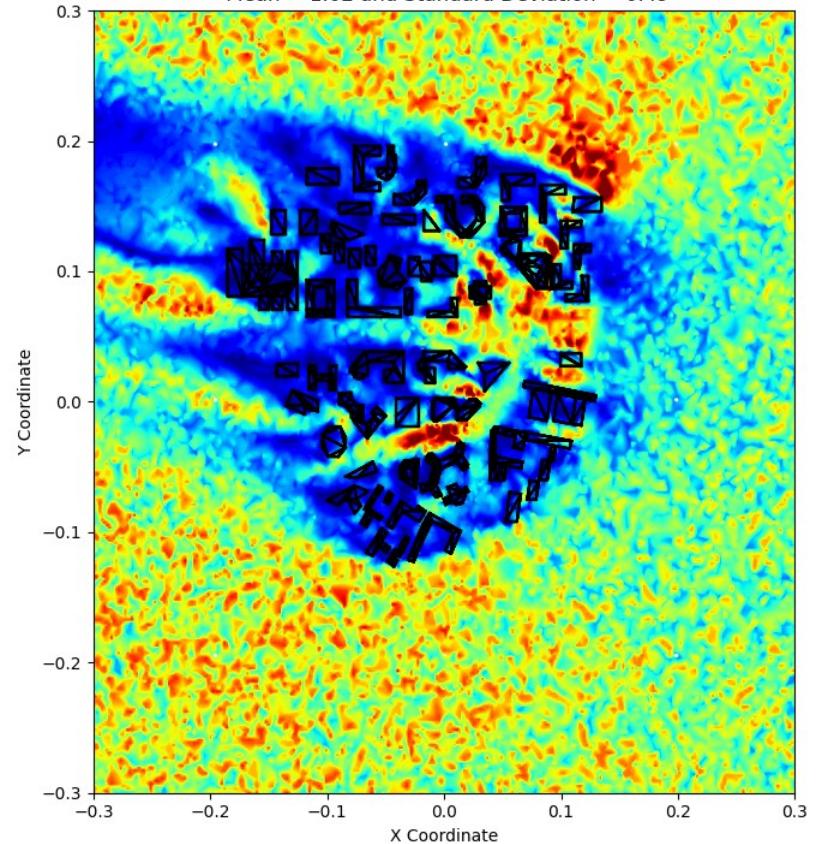


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.43

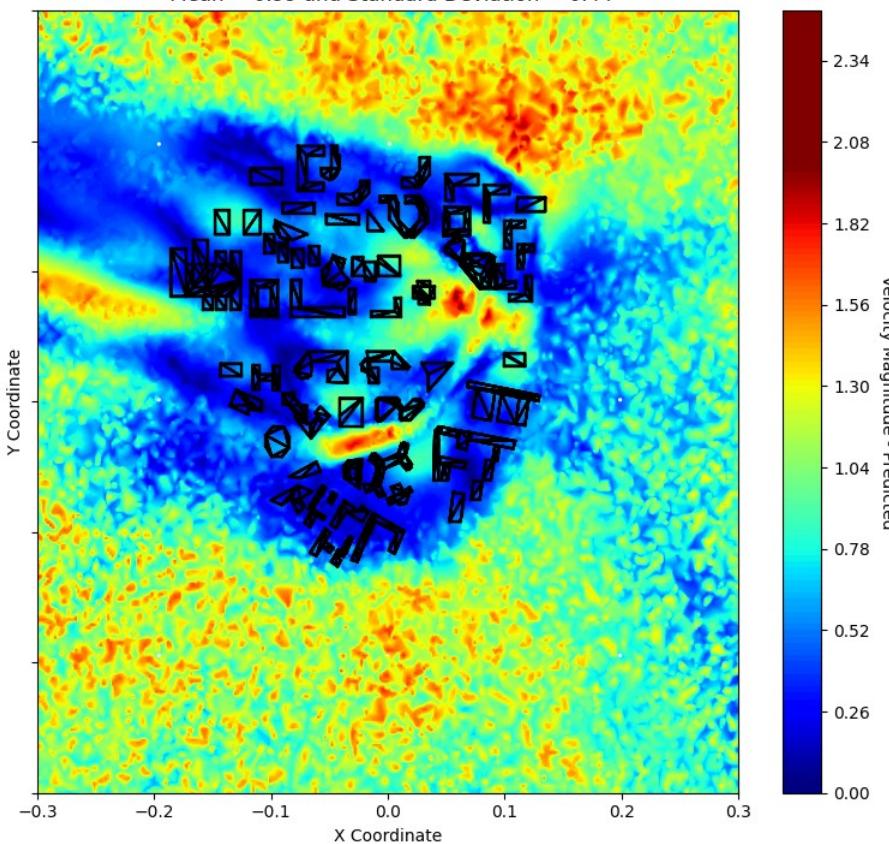


Comparison of Actual vs. Predicted values with Wind Angle = 105 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.49

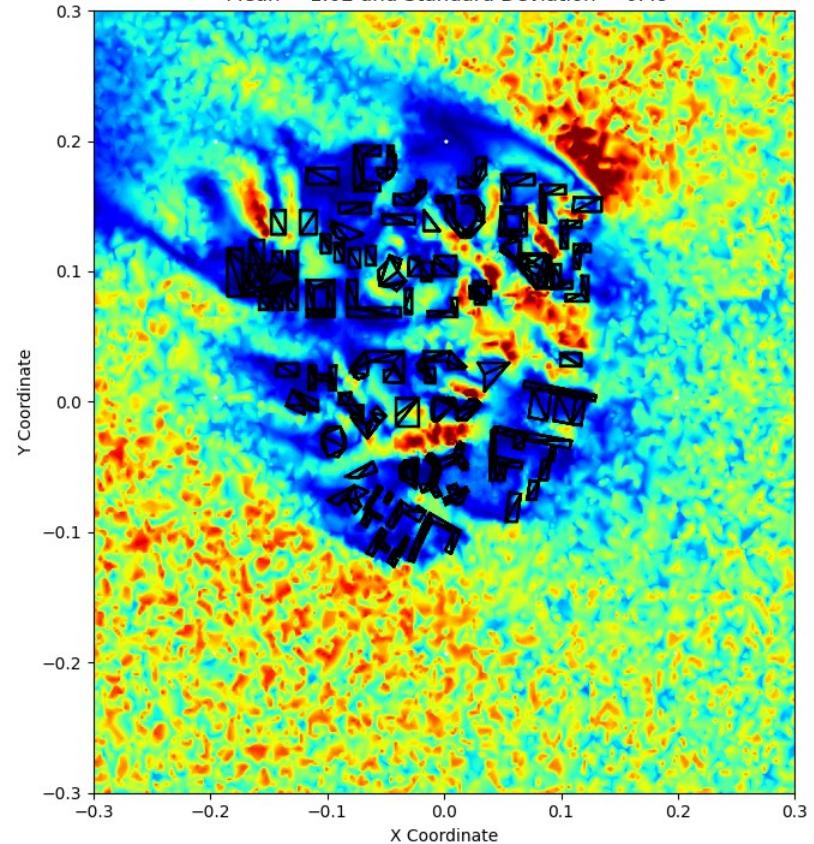


Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.01 +/- 0.01
Mean = 0.99 and Standard Deviation = 0.44

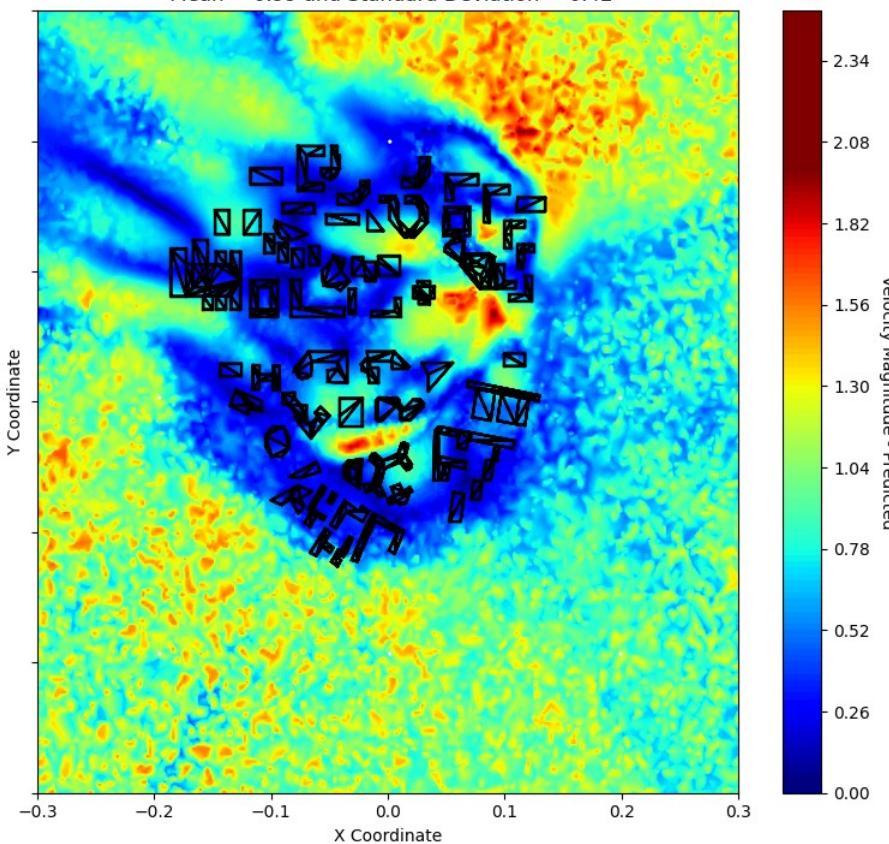


Comparison of Actual vs. Predicted values with Wind Angle = 120 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.49



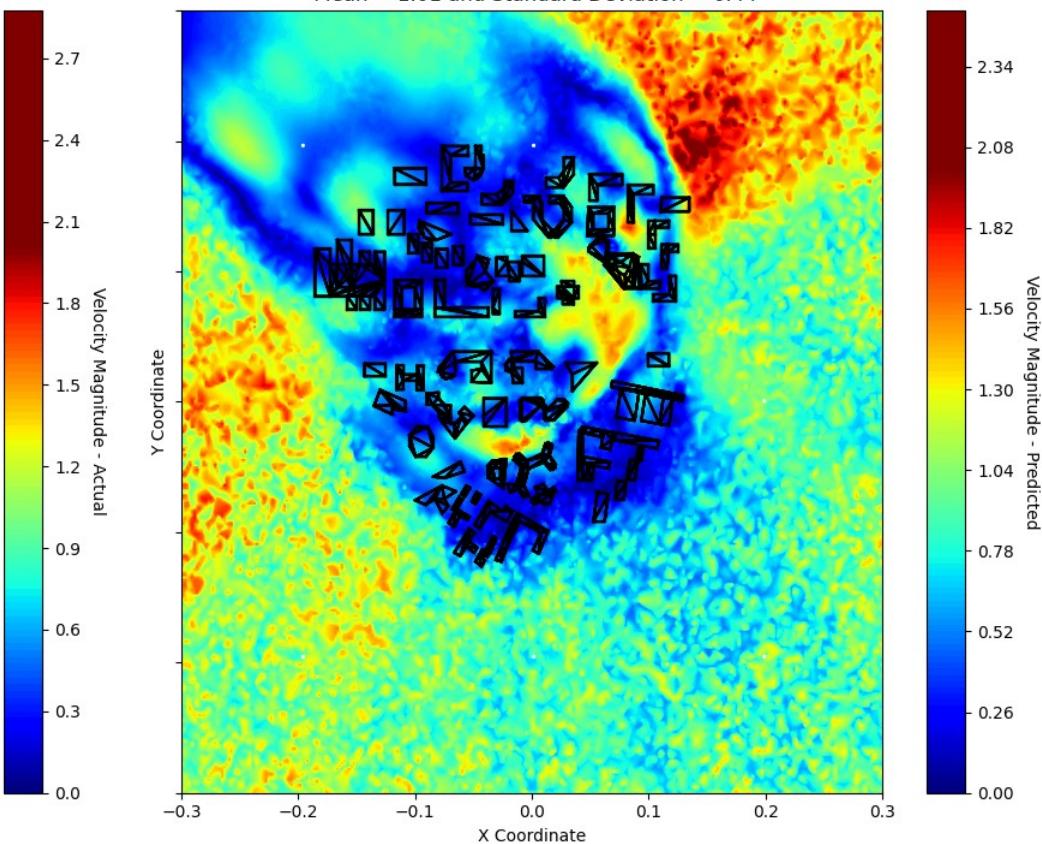
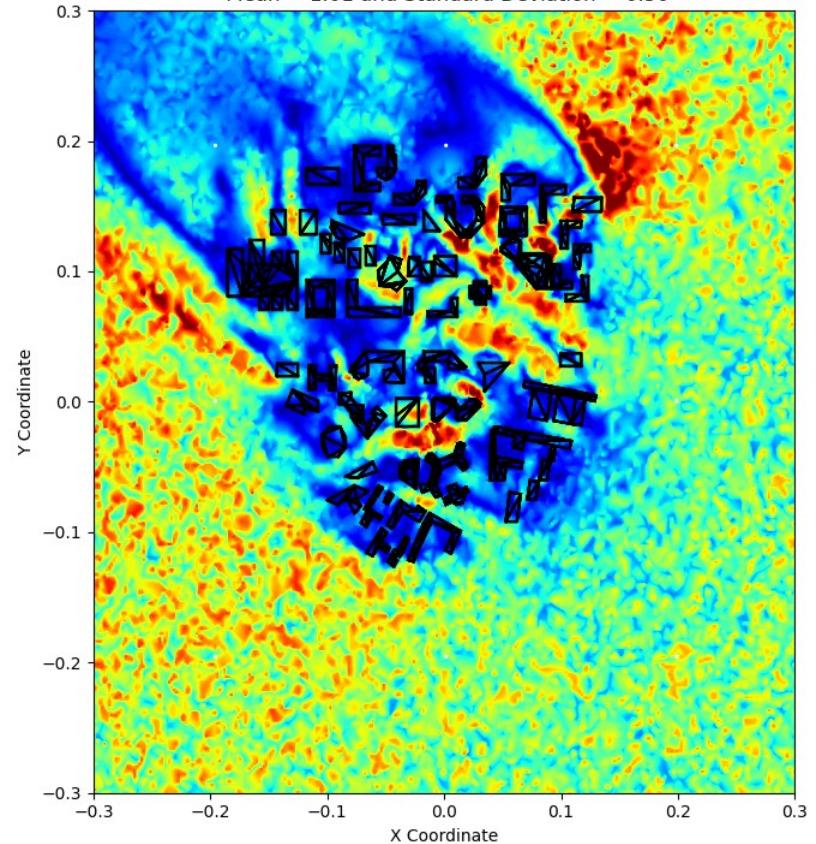
Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.01 +/- 0.01
Mean = 0.99 and Standard Deviation = 0.42



Comparison of Actual vs. Predicted values with Wind Angle = 150 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

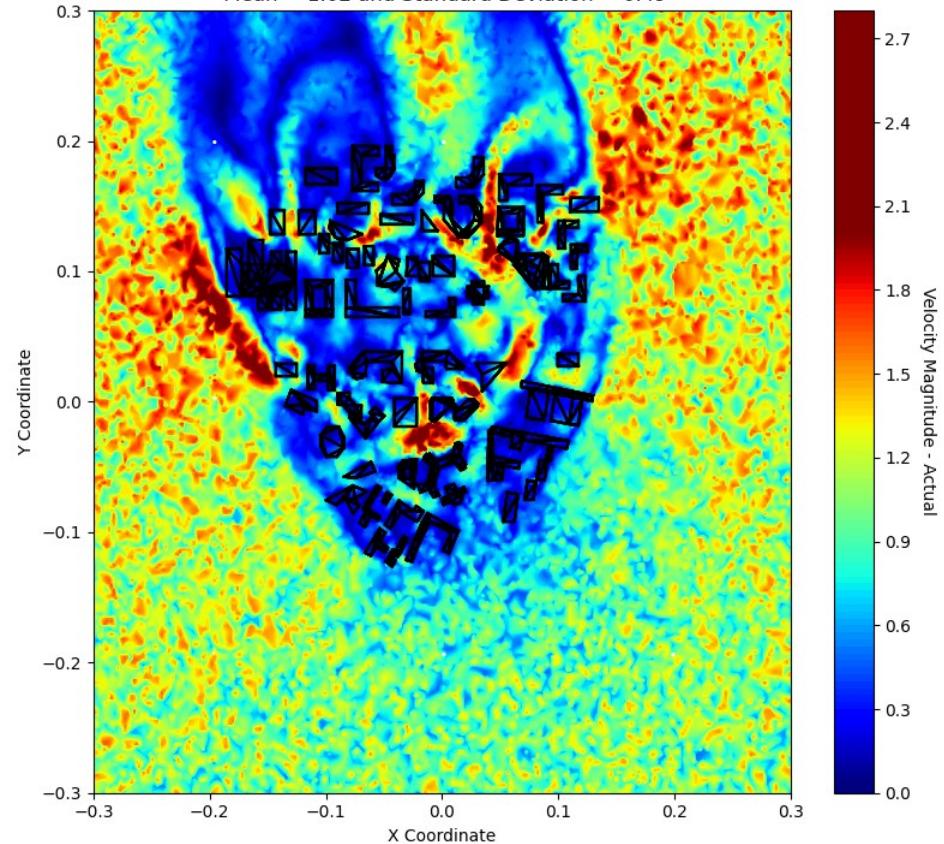
Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.50

Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.44

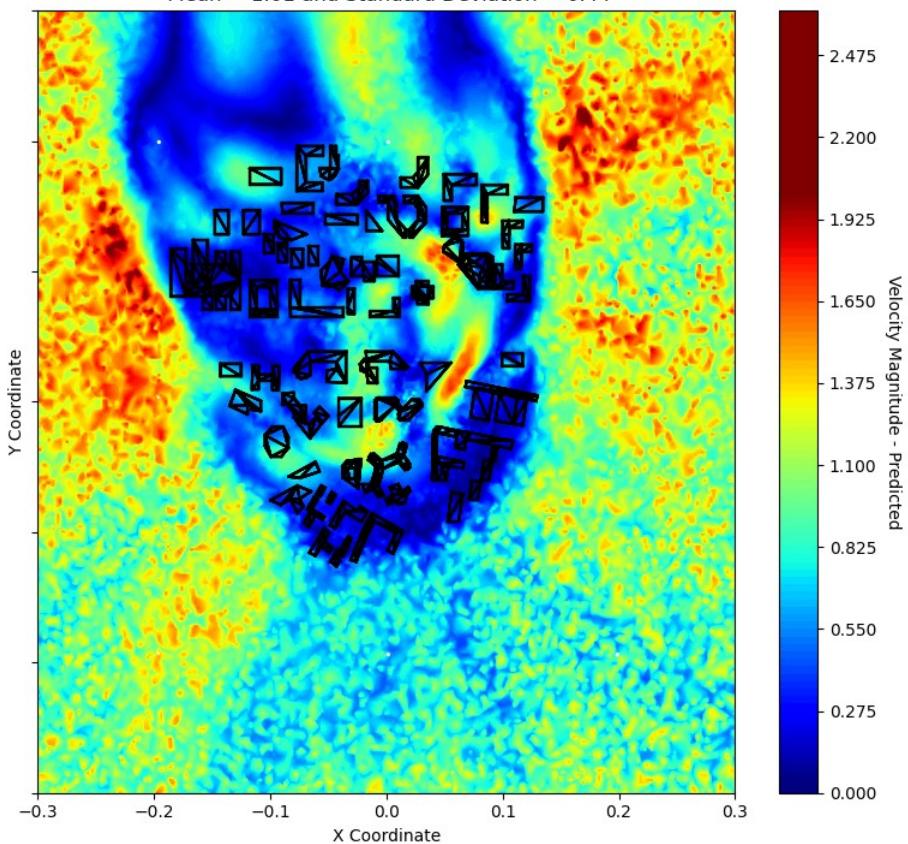


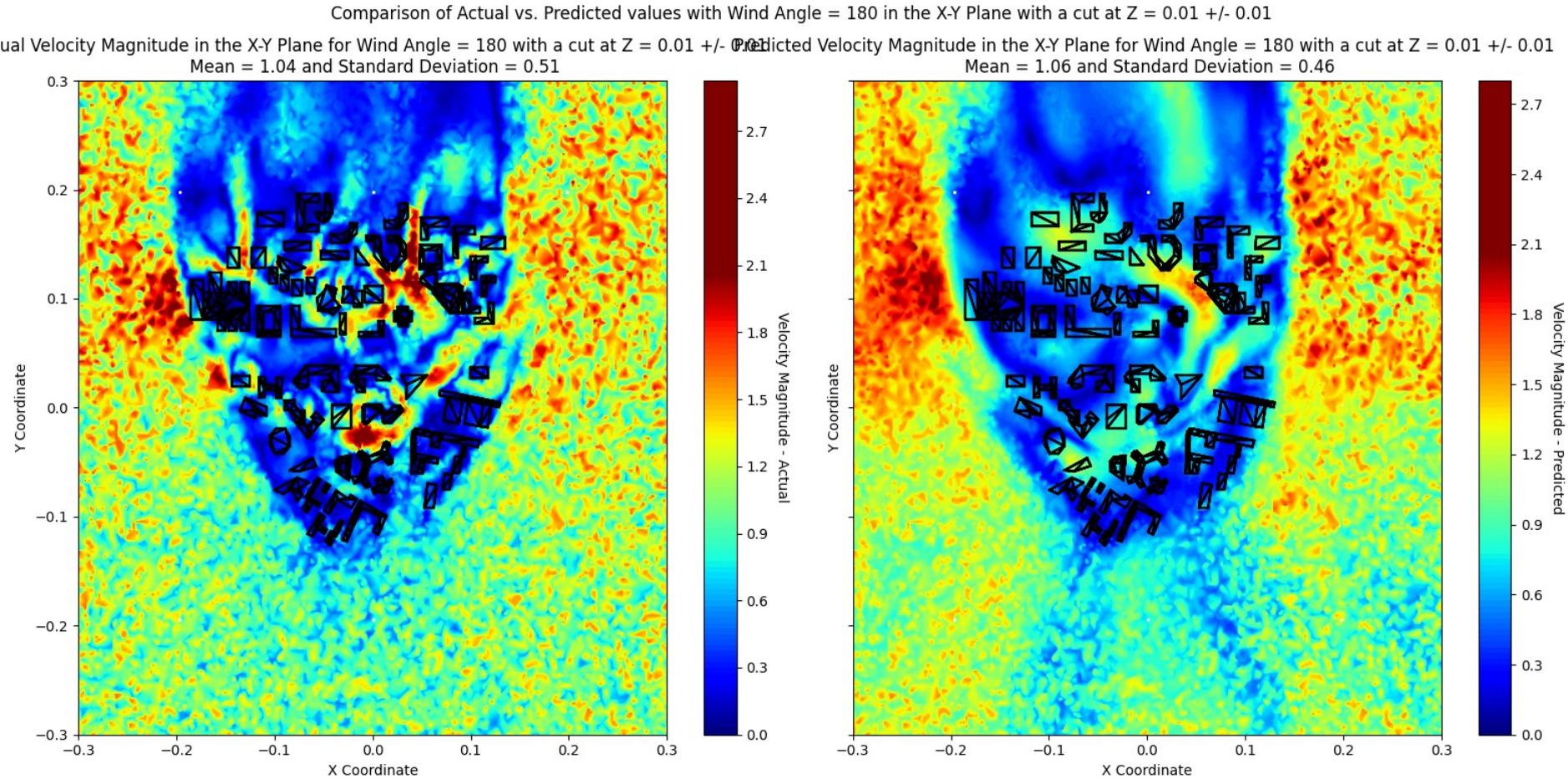
Comparison of Actual vs. Predicted values with Wind Angle = 165 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.49



Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.44





Progress so far - Data Loss Only
Standard Normal Scalar – ELU Activation
(Adam Optimizer)

Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop

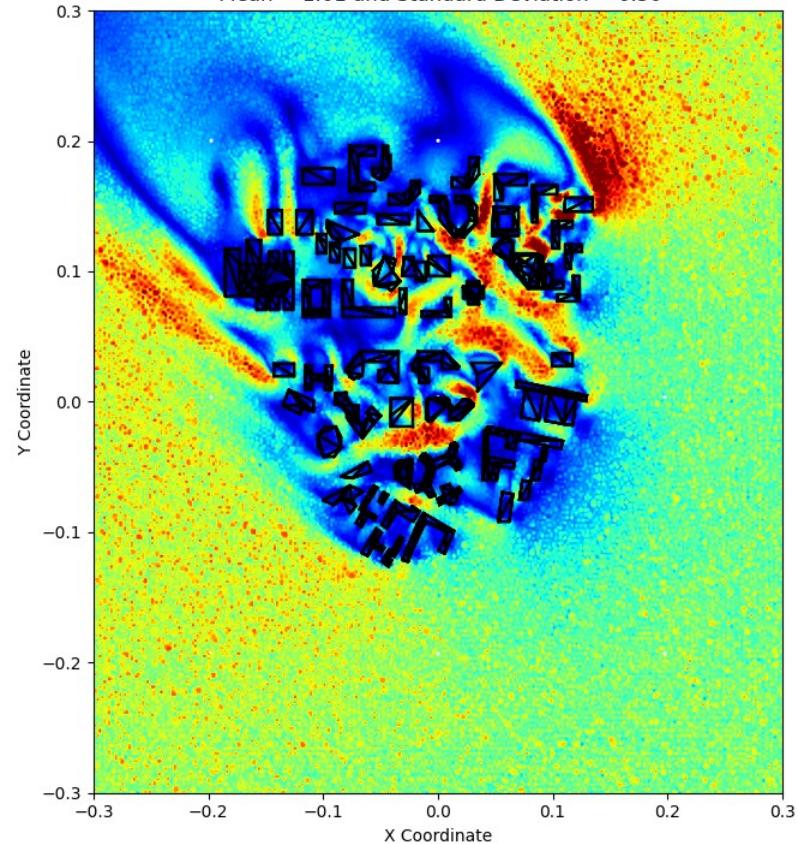
Scripts v5 – PREDICTING

Progress so far - Data Loss Only, Standard Normal Scalar, ELU Activation, Adam Optimizer
Threshold = SMA 1E-5 (46 Epochs, not completed), GPU Laptop
Predicting Results – Metrics (Angle = 135)

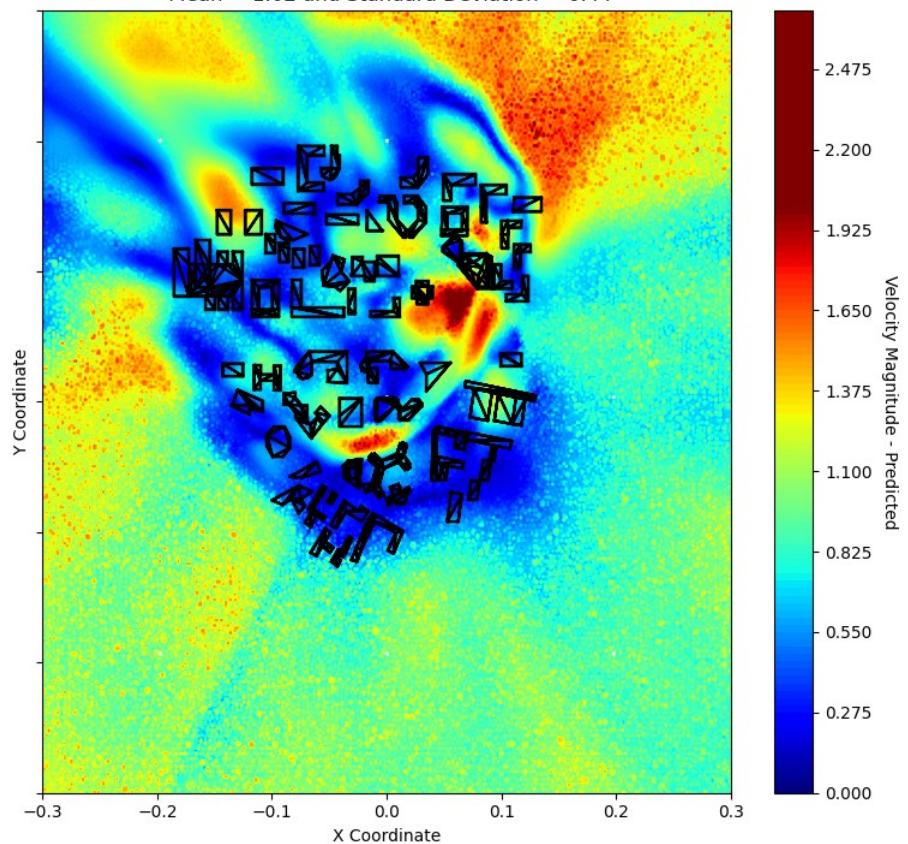
Variable	MSE	RMSE	MAE	R2
Velocity:0	0.20157854	0.44897499	0.38814642	0.81321494
Velocity:1	0.18665966	0.43204127	0.37654395	0.83626727
Velocity:2	0.00775738	0.08807601	0.03591697	0.59301743

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.01 +/- 0.01

Actual Velocity Magnitude in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.01 +/- 0.01
Mean = 1.01 and Standard Deviation = 0.50



Predicted Velocity Magnitude in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.01 +/- 0.01
Mean = 1.02 and Standard Deviation = 0.44



Some Next Steps

Paraview plots (automate? animation?)